BOTANICAL GAZETTE

JANUARY, 1894.

Undescribed plants from Guatemala. XII.

JOHN DONNELL SMITH.

WITH PLATES I AND II.

M. Casimir de Candolle has contributed to this article diagnoses and descriptions of new species among the MELIACEÆ and PIPERACEÆ submitted to him for elaboration.

Peltostigma pentaphyllum.—Petioles half to two-thirds as long as leaves; leaflets 5, obovate-oblong to elliptical-oblong (6–8 × 2–2.5^{in}), the exterior pair reduced, acuminate, tapering to petiolule, entire: peduncle with 3-flowered cyme subequalling petiole, pedicels ebracteate; sepals chiefly 4; 2 exterior herbaceous, ovate (1–2^{l}): petals chiefly 5, exceeding interior sepal (8^{l}): ovary 7–10-locular, truncate-conic, as broad as gynophore (3^{l}); stigmas before anthesis sacciform, oval (1.5 × 1^{l}); capsule globose, the matured not seen.—A tree 15–21^{ft} high with spreading branches. *P. pteleoides* Walp., which has been the monotype of the genus, and recorded only from Jamaica, differs by short petioles, ternate smaller leaflets, compound inflorescence equalling leaves, smaller flowers, less numerous and less unequal parts of perianth.—Zamorora, Depart. Santa Rosa, alt. 5,500^{ft}, March 1892 and April 1893, Heyde & Lux, (ex Pl. Guatemal. qu. edid. J. D. S. 3,058 and 4,437).

Cabralea insignis C. DC.—Foliis maximis modice petiolatis abrupto-pinnatis 19-jugis, foliolis oppositis sessilibus anguste oblongis basi æquali subacutis obtusisve apice obtusiuscule cuspidatis utrinque glabris, nervis secundariis subpatulis tenuibus utrinque 25 et plus, fructu globoso glabro loculis monospermis.—Arbor? Folium totum ad 65^{cm} longum. Foliola ad 14.5^{cm} longa 2.5^{cm} lata in sicco membranacea sub-

pellucida læte virescentia subtiliter pellucido-punctulata verruculis porosis destituta. Rhachis teres. Petiolus 10^{cm} longus. Fructus indehiscens circiter 4.5^{cm} in diametro, lævis in sicco fuscescens. Semina elliptica circiter 18^{mm} longa. Cotyledones carnosi coriacei elliptici, radicula intra cotyledones immersa.—Species magnitudine foliorum insignis, *C. pallescentis* C. DC. subaffinis.—Acatepeque, Depart. Zacatepequez, alt. 4,300^{ft}, March 1892, J. D. S., no. 2,570.

Guarea Luxii C. DC. —Foliis modice petiolatis 3-jugis, foliolis brevissime petiolulatis oppositis lanceolatis subæqualibus supra glabris subtus junioribus adpresse pilosulis cito glabris, rhachi adpresse hirsuta, paniculis quam folii dimidium brevioribus simplicibus modice pedunculatis spicatim cymuligeris, floribus longiuscule pedicellatis, calyce cupuliformi extus adpresse hirtello margine brevissime acute 4-denticulato, petalis glabris oblongis apice acutis, tubo glabro cylindrico margine obtuse 8-crenulato, antheris oblongis glabris, ovario glabro ovato stipitem superante apice in stylum glabrum attenuato.—Frutex aut arbor 4–6^{m} alta, ramulis junioribus adpresse pubescentibus cito glabris lævibus subcinerascentibus, fructiferis in sicco circiter 2^{mm} crassis. Foliola in sicco membranacea firmulave subpellucida crebre minute pellucido-punctulata ad 9.5^{cm} longa et ad 3^{cm} lata, nervis secundariis subpatulis tenuibus utrinque circiter 15. Petioluli vix 2^{mm} longi. Petioli ad 5^{cm} longi. Flores circiter 3^{mm} longi. Petala 4 æstivatione valvata in sicco rubescentia. Antheræ 8 tubi denticulis oppositæ parvæ. Ovarium 4-loculare loculis uniovulatis. Capsula in specimine nondum matura subglobosa glabra circiter 12^{mm} longa.—Species *G. pedicellatæ* C. DC. et *G. Shomburgkii* C. DC. affinis.—S. Rosa, Depart. S. Rosa, alt. 3,000^{ft}, March 1892, Heyde & Lux, no. 3,276.

Trichilia Donnell-Smithii C. DC. —Foliis modice petiolatis 4–5-jugis, foliolis breviter petiolulatis plerumque oppositis subæqualibus e basi cuneata obovato-oblongis apice rotundatis obtusisve vel breviter obtusiuscule acuminatis utrinque breviter haud dense pilosulis, paniculis e basi decompositis quam petioli brevioribus, floribus longiuscule pedicellatis, calyce acute profunde 5-dentato extus dense hirtello, petalis 5 extus adpresse hirtellis ellipticis apice subacutis, staminibus medium usque in tubum urceolatum glabrum connatis sursum laciniosis laciniis utrinque pilosis apice acute 2-dentatis, an-

theris 10 glabris oblongis apice acutis, ovario globoso glabro in disco carnoso glabro subcupuliformi insidente 3-loculari, loculis 2-ovulatis, capsulæ glabræ 3-valvatæ loculis monospermis, seminibus ellipticis arilloque rubris.—Ramuli juniores hirsuti dein subglabri in sicco fuscescentes elenticellosi. Folia ad 16^{cm} longa. Foliola ad 8^{cm} longa ad 2.5^{cm} lata in sicco firma subopaca epunctata, nervis secundariis plerumque alternis subadscendentibus utrinque circiter 8–10. Rhachis cum petiolo 3^{cm} longo teres hirtella. Floris pedicellus 2^{mm} longus. Petala 9^{mm} longa in sicco flavicantia. Antheræ inter laciniarum dentes sessiles. Ovarii loculi oppositisepali, ovulis superpositis. Stylus glaber ovario æquilongus. Seminis testa dura. Embryo intra perispermium album carnosum inclusus, cotyledonibus foliaceis elliptico-rotundatis basi breviter cordulatis, radicula exserta brevi, plumula minima. — Species quoad floris structuram in sectione EUTRICHILIA *(C.DC. monogr.)* collocanda sed propter semen perispermium includens ab omnibus Trichiliis quorum fructus notus discrepans.—Laguna Amatitlan, Depart. Amatitlan, alt. 3,900^{ft}, March 1890, J. D. S., no. 1,908; Volcan de Fuego, Depart. Zacatepequez, alt. 5,500^{ft}, March 1892, J. D. S., 2,504.

Var. *β.* **Uniovulata** C. DC.—Staminum laciniis extus glabris, ovarii loculi uniovulati. — Folia inferiora 1–2-juga cum impari foliolis lateralibus multum majore ad 9^{cm} longo et ad 5^{cm} lato, superiora ut in specie.—Guarda Viejo, Depart. Guatemala, alt. 5,000^{ft}, Febr. 1890, J. D. S., no. 1,909.

Trichilia Heydeana C. DC. — Foliis modice petiolatis 3–4-jugis, foliolis subæqualibus brevissime petiolulatis lanceolato-oblongis basi æquali acutis apice obtuse cuspidatis supra puberulis subtus dense molliter fulvescente-pubescentibus paniculis quam folia multum brevioribus dense pubescentibus, fere a basi ramosis, floribus breviter pedicellatis, calyce extus dense pubescente profunde acute 5-dentato, petalis 5 extus pubescentibus lanceolatis, staminibus inferne in tubum brevem glabrum cum disco connatum coalitis sursum laciniosis laciniis apice obtusis utrinque et intus densius hirsutis, antheris hirtellis avatis apice acutis, ovario disco lato supra villoso insidente villose 3-loculari.—Arbor 10–12^{m} alta. Ramuli juniores adpresse fulvescente-hirsuti, dein glabri in sicco fuscescentes lenticellis concoloribus. Limbi ad 12^{cm} longi ad 4.5^{cm} lati in sicco subcoriacei opaci crebre pellucido-punctulati, nervis secundariis utrinque circiter 12 patule subadscendentibus.

Petioli ad 2^{mm} longi. Rhachis cum petiolo 3^{cm} longo teres dense fulvescente-hirsuta. Paniculæ rami ad 7^{cm} longi fere a medio brevissime ramulosi, ramulis apice dense cymuligeris. Florum pedicelli 1^{mm} parum superantes. Alabastra subglobosa. Calycis dentes lanceolati. Petala circiter 2^{mm} longa in æstivatione imbricata. Antheræ 10 lacinias subæquantes.—Species *T. Wawranæ* C. DC. et *T. Glaziovii* C. DC. affinis.—Naranjo, Depart. Escuintla, alt. 300^{ft}, March 1892, J. D. S., no. 2,574; Rio Esclavos, Depart. S. Rosa, alt. 3,000^{ft}, May 1892, Heyde & Lux, no. 3,274; S. Rosa, alt. 3,000^{ft}, May 1892, Heyde & Lux, no. 3,275.

Cedrela impari-pinnata C. DC. — Foliis longe petiolatis impari-pinnatis 3–5-jugis, foliolis lanceolatis basi æquali acutis apice acute acuminatis subæqualibus utrinque puberulis lateralibus oppositis subsessilibus rhachi puberula, capsula oblonga glabra 4-valvata seminibus elliptico-oblongis.—Ramuli juniores puberuli dein glabri læves in sicco fuscescentes, cortice tenui. Folia cum impari ad 34^{cm} longa. Foliola in sicco membranacea subpellucida subtiliter pellucido-punctulata ad 8^{cm} longa ad 3^{cm} lata, nervis secundariis subpatulis utrinque circiter 12. Capsula circiter 5^{cm} longa valvis lanceolatis medio circiter 12^{mm} latio. Semen cum ala 3^{cm} longum, ala tenuissima. Species foliis impari-pinnatis insignis, *C. Velloziana* Rœm. quoad foliorum formam affinis.—Volcan de Fuego, alt. 6,000^{ft}, March 1892, J. D. S., no. 2,571.

Oreopanax Taubertianum.—Primordial leaves broadly triangular; petioles robust, base abruptly broadly dilated and amplexicaul; leaflets digitately 5–9, chiefly 7, obovate-elliptical (6–9×2–3^{in}), acutely acuminate, tapering to petiolule, coarsely and sharply toothed above middle, membranaceous, upper surface furfuraceous or glabrate, the lower stellate-pubescent, areolation minute and pellucid-punctulate: staminate racemes elongated (16–24^{in}), curving; pedicels pubescent, crowded, slender, thrice exceeding small (3^{l}) globose heads; petals 4–5, shorter than filaments, twice longer than single style; bracteoles surpassing ovary by their pubescent tips, the subtending one narrowly obovate; abortive ovary shortly obpyramidate: fruiting racemes somewhat shorter, pedicels longer (9-15^{l}), heads 5–12-baccate; berries ovoid, crowned with 5 semiconnate styles, by abortion 2–5-celled and with as many or fewer nucules, albumen ruminate.—Compared in the Berlin Herbarium by Dr. Taubert with specimens, authenticated

by M. Marchal, of *O. Xalapense* Dcne et Planch. The only other species described with digitate leaflets, *O. Thibautii* Hook. f., is reduced by M. Marchal to a form of *O. Xalapense* (cf. Bull. Soc. Roy. Bot. Belg. **30**: 282).—A tree 30–40^{ft} high with branchlets half-encircled by the scars of fallen leaves, known to the natives as *Mata-gente*.—Barranca de Corona, Depart. Guatemala, alt. 4,700^{ft}, Febr. 1890 and 1892, J. D. S., nos. 1,905 and 2,664; S. Rosa, alt. 4,000^{ft}, March 1892, Heyde & Lux, no. 3,096; Chiapas, Depart. S. Rosa, alt. 3,500^{ft}, Sept. 1892, Heyde & Lux, no. 3,967.

Ardisia paschalis.—Glabrous: leaves obovate or elliptical (6–7.5 × 3–3.5^{in}), obtuse, narrowing to short canaliculate marginate petiole, entire, coriaceous, nitid, rubro-punctate and -striolate: panicle terminal, exceeding leaves; flowers racemose on primary branches, single, 5-merous, rubro-maculate, pedicels longer and in fruit nodding: divisions of calyx convolute, round-ovate (1.5^{l}): corolla in præfloration dextrorsely contorted, yellowish-white, the conspicous stellate centre thickened by dark-yellow pigment-cells, tube minute (half a line) and equalling explanate throat, obtuse segments oblong (4^{l}) and revolute: stamens slightly monadelphous at apex of tube; anthers ovoid-oblong (2^{l}), twice exceeding filaments, apiculate, before anthesis cohering in a cone by longitudinal sutures of of dehiscence: ovary ovoid, style filiform: fruit pisiform (3–4^{l}), endocarp crustaceous.—A shrub 6–9^{ft} high, with fragrant and showy flowers that are singularly large for the genus, called by the natives *Chilil*, and used during Easter week for decorating the altars of the churches.—Cuyotenango, Depart. Suchitepequez, alt. 1,100^{ft}, April 1892, J. D. S., no. 2,465; S. Rosa, alt. 3,000^{ft}, May 1892, Heyde & Lux, no. 3,023; Cerro Gordo, Depart. S. Rosa, alt. 3,500^{ft}, Sept. 1892, Heyde & Lux, no. 3,988; Casillas, Depart. S. Rosa, alt. 4,000^{ft}, May 1893, Heyde & Lux, no. 4,537. Collected also along Rio Permejo, S. Pedro Sula, Honduras, July 1887, by Dr. C. Thieme.

Explanation of Plate I.—Fig. 1, branch with flowers. Fig. 2, branch with fruit. Fig. 3, portion of leaf. Fig. 4, flower-bud. Fig. 5, open flower. Fig. 6, stamens. Fig. 7, pistil. Fig. 8, half of a corolla with stamens. Fig. 9, vertical section of fruit. (Figs. 1 and 2 are natural size; in the others the objects are variously enlarged.)

Piper Luxii C. DC. (§ III. Steffensia C. DC.)—Foliis modice petiolatis elliptico-lanceolatis basi inæquali acutis supra præsertim ad nervos subtusque densius breviter hirsutis,

nervo centrali vix ad ½ longitudinis suæ nervos adscendentes utrinque 5 mittente, petiolo hirsuto basi vaginante, pedunculo quam petiolus breviore, amento ipso per anthesin limbi dimidium vix æquante apice mucronato, bractea obovato-oblonga apice rotundata utrinque dense villosa, filamentis elongatis antheris ellipticis quam filamenta pluries brevioribus, ovario conico parce piloso apice in stylum circiter eo æquilongum glabrum attenuato, stigmatibus liŋearibus recurvis.—Ramuli juniores dense villosi dein subglabrati, in sicco nigrescentes læves, amentiferi circiter 2^{mm} crassi, collenchymate in cortice continuo zona fibrosa continua intus aucto, fasciculis intramedularibus uniseriatis. Limbi in sicco membranacei nigrescentes pellucido-punctulati ad 20^{cm} longi ad 9^{cm} lati, juniores læves dein supra subbullati. Petiolus ad limbi latus longius circiter 2^{cm} longus. Amentum per anthesin circiter 6^{mm} crassum. Stamina 4 filamentis longis exsertis. Stigmata 3.—Species *P. Irazuani* C. DC. proxima, ab eo nervorum numero bractea apice obtusa ac longius densiusque pubescente et antheris oblongis discrepans.—San Miguel Uspantán, Depart. Quiché, alt. 6,000^{ft}, April 1892, Heyde & Lux, no. 3,462.

Piper Uspantanense C. DC.—Foliis breviter petiolatis elliptico-lanceolatis basi parum inæquali utrinque acutis apice longe acute acuminatis supra glabris subtus ad nervos nervulosque adpresse hirtellis nervo centrali circiter medium-usque nervos utrinque 4 alternos adscendentes nervulosque validos mittente, petiolo basi ima vaginante dorso hirtello, pedunculo quam petiolus circiter ⅓ longiore puberulo, amento ipso limbi dimidium vix æquante apice mucronulato, bracteæ pelta triangulari margine dense et longiuscule hirsuta pedicello extus piloso, antheris subglobosis quam filamenta brevioribus, ovario glabro, bacca glabra.—Suffrutex 1–1.5^{m} altus, ramulis junioribus hirtellis dein glabris punctulis albis conspersis, 2.5^{mm} crassis in sicco teretibus, collenchymate in cortice subcontinuo zonaque fibrosa discontinua intus aucto, fasciculis intramedullaribus uniseriatis. Limbi in sicco membranacei obscure virescentes subopaci creberrime pellucido-punctati ad 20^{cm} longi. Amenta nondum matura 2^{mm} crassa. Stamina 4 connectivo supra loculos brevissime producto. Bacca tetragona stylo destituta vertice in sicco rufescens. Stigmata 3.—San Miguel Uspantán, alt. 8,000^{ft}, April 1892, Heyde & Lux, no. 3,460; Cerro Gordo, Depart. S. Rosa, alt. 3,500^{ft}, Sept. 1892, Heyde & Lux, no. 3,827.

Piper Yzabalanum C. DC. in Donnell Smith Enum. Pl. Guat. pars II.—Foliis longiuscule petiolatis ample ovatis basi inæquali cordulatis apice breviter acute acuminatis utrinque glabris, nervo centrali paulo ultra medium nervos utrinque 7 patule adscendentes mittente, petiolo glabro limbum usque vaginante, pedunculo quam petiolus adultus 4-plo breviore glabro, amento quam folium pluries breviore apice breviter mucronato, bracteæ spathulatæ vertice inflexo triangulari glabro pedicello lato basi inter baccas producto et hirtello, bacca glabra vertice pulposa.—Ramuli glabri punctulis albis notati in sicco complanati 4–5^{mm} crassi, fasciculis collenchymatosis in cortice distinctis intus fibris aliquot auctis, fasciculis intramedullaribus uniseriatis. Limbi 18^{cm} longi circiter 12^{cm} lati in sicco membranacei pellucido-punctulati. Petioli circiter 4^{cm} longi. Amenta matura ad 6.5^{cm} longa 5^{mm} crassa. Baccæ subtetragonæ stylo destitutæ vertex pulposus in sicco ambitu subproductus. Stamina 4. Stigmata 3.—Boca del Polochic, Depart. Yzabal, alt. 200^{ft}, April 1889, J. D. S., no. 1,712.

Piper Heydei C. DC. (§V. POTOMORPHE C. DC.)—Foliis longe petiolatis adultis $\frac{1}{3}$ supra limbi basin peltatis ovato-rotundatis amplis basi rotundatis repando-subcordatis apice breviter acute acuminatis supra glabris subtus præsertim ad nervos nervulosque fulvescenti-hirsutis 14-plinerviis nervo centrali nervos adscendentes utrinque 3 supra limbi basin et ad $\frac{1}{4}$ longitudinis mittente cæteris nervis e petiolo divaricantibus, petiolo medium usque vaginante dorso apicem versus parce hirsuto, amentis apice ramuli sat longi glabri circiter 12-umbellatis longiuscule pedunculatis ipsis florentibus quam foliorum limbi pluries brevioribus, bracteæ pelta triangulari margine fulvescente hirsuta, antheris subglobosis, ovario glabro.—2^{m} altum. Folia juvenilia haud peltata basi cordata. Limbi in sicco firmule membranacei subopaci pellucido-punctati 33^{cm} longi medioque lati. Petioli adulti circiter 16^{cm} longi. Ramuli amentiferi glabri verisimiliter axillares 16^{cm} longi. Amentorum pedunculi 5^{cm} longi. Amenta ipsa adhuc juvenilia inæquilonga ad 9^{cm} longa. Stamina 3 quorum 2 lateralia tertium posticum. Antheræ filamentis circiter æquilongæ. Ovarium ovatum apice attenuatum adhuc juvenile.—Species limbis subtus hirsutis, ramulis amentiferis multo longioribus et præsertim floribus 3-staminalibus a *P. peltato* L. valde discrepans.—San Miguel Uspantán, alt. 7,000^{ft}, April 1892, Heyde & Lux, no. 3,461.

PIPER TUBERCULATUM Jacq. ic. rar., var. δ. **obtusifolium** C. DC.—Foliis apice rotundatis cæterum ut in specie.—Frutex 3[m] altus.—Rio Ocosito, Depart. Quezaltenango, alt. 250[ft], April 1892, J. D. S., no. 2,592; S. Rosa, alt. 3,000[ft], June 1892, Heyde & Lux, no. 3,464. Collected also near Grenada, Nicaragua, by Lévy, no. 93.

Peperomia macrophylla C. DC. — Foliis petiolatis anguste lanceolato-oblongis basi in petiolum decurrentibus apice acute acuminatis utrinque glabris pellucido-punctulatis penninerviis, nervo centrali fere a tota longitudine nervos adscendentes utrinque circiter 10 mittente, amentis ad ramos axillares aphyllos quam folia parum breviores laxe circiter 5 paniculatim dispositis ipsis breviter pedunculatis folii dimidium vix æquantibus, bractea suborbiculari centro brevissime pedicellata, ovario apice oblique scutatim complanato scutello elliptico apice obtuso in medio stigma carnulosum gerente, bacca anguste cylindrica patenti glabra apice scutello persistente erecto subacute terminata.—Herba glabra caule basi decumbente e nodis radicante superne suberecta. Folia alterna. Limbi ad 20[cm] longi et ad 3.5[cm] lati in sicco membranacei subpellucidi basi in petiolum ad 3[cm] longum angustati. Amenta matura in sicco 2[mm] crassa, basi squamis lanceolatis deciduis fulta, inferiora 2 alterna superiora 2 opposita ultimum terminale. Pedunculi circiter 5[mm] longi. Antheræ minutæ. Baccæ brevissime stipitatæ cum scutello 1.5[mm] longæ.—Palin, Depart. Amatitlan, alt. 3,560[ft], Feb. 1892, J. D. S., no. 2,578; Barranca de Eminencia, Depart. Amatitlan, alt. 1,400[ft], Feb. 1892, J. D. S., no. 2,579.

Peperomia violæfolia C. DC. — Foliis longe petiolatis e basi cordata inferioribus rotundatis superioribus ovatis apice acute acuminatis utrinque glabris 7–9-nerviis, amentis oppositifoliis sublaxifloris breviter pedunculatis glabris foliorum limbos parum superantibus, bractea orbiculari centro pedicellata, ovario emerso stipitato obovato-elliptico apice imo stigma minutum carnulosum gerente, bacca elliptica breviter stipitata. —Herba glabra e stolone caules multos circiter 10[cm] altos in sicco membranaceos ad 3[mm] crassos dense agens. Folia alterna. Limbi in sicco tenuiter membranacei pellucidi haud crebre pellucido-punctati 6–7[cm] longi 5–6.5[cm] lati. Petioli ad 7[cm] longi. Pedunculi circiter 1[cm] longi. Amentia florentia in sicco membranacea pellucida 1.5[mm] crassa. Ovarium stipite suo parum breviore. Bacca stipitem suum pluries superans circiter ad 1[mm] longa. Palin, alt. 3,500[ft], Feb. 1892, J. D. S., no. 2,580.

Peperomia Sisiana C. DC.—Foliis modice petiolatis oblongo-lanceolatis basi acutis apice longiuscule anguste et subfalcatim acuminatis utrinque glabris junioribus margine ciliolatis 7-plinerviis nervis lateralibus utrinque 2 e basi uno ex $\frac{1}{4}$ longitudinis supra basin solutis, petiolo juniore parce hirtello, amentis adultis folia duplo superantibus filiformibus glabris densifloris, bractea orbiculari centro subsessile, ovario emerso apice scutatim aucto, scutello in medio stigmatifero apice acuminato, stigmate minuto, bacca emersa patente cylindrica apice oblique rostellata.—Herba e basi radicante ramulos circiter 25^{cm} longos erectos apice parce hirtellos inferne glabros agens. Folia alterna. Limbi in sicco membranacei subpellucidi ad 9^{cm} longi et 3–3.5^{cm} lati. Petioli ad 1^{cm} longi. Amenta matura vix 2^{mm} crassa. Baccæ 1.5^{mm} longæ.—Species *P. Naranjoanæ* C. DC. proxima, forsan eadem cum amentis maturis longioribus, limbis basi acutis a *P. elongata* Kunth differt sed ejus quoque proxima.—Rio Sis, Depart. Suchitepequez, alt. 1,300^{ft}, April 1892, J. D. S., no. 2,584.

Peperomia San-Felipensis C. DC. — Foliis breviter petiolatis anguste lanceolatis basi et apice acutis utrinque glabris et nigro-pynctulatis 5-nerviis, amentis terminalibus axillaribusque breviter pedunculatis glabris nigro-punctulatis subdensifloris ipsis folia circiter duplo superantibus, bractea orbiculari centro subsessili, ovario emerso sub apice oblique stigmatifero, bacca subglobosa glabra.—Herba repens glabra caulibus in sicco 1.5^{mm} crassis. Folia alterna. Limbi in sicco firmulo-membranacei subpellucidi 3–4^{cm} longi 8–10^{mm} lati nervis subtilibus. Petioli 6^{mm} longi. Pedunculi vix 5^{mm} longi. Amenta 1^{mm} crassa. Species *P. glabellæ* Sw. proxima limbis angustioribus nervorum numero ramulisque glabris ab ea discrepans. —San Felipe, Depart. Retalhuleu, alt. 2,050^{ft}, April 1892, J. D. S., no. 2,583.

Peperomia Heydei C. DC. — Foliis longissime petiolatis ovato-rotundatis basi cordatis apice rotundatis 9–11-nerviis utrinque glabris, amentis terminalibus axillaribusque glabris longe pedunculatis foliorum limbos circiter æquantibus, floribus annulatim dispositis, bractea orbiculari, ovario obovato apice oblique complanato oblique stigmatifero.—Herba glabra caule decumbente basi radicante in sicco tenuiter membranacea pellucida. Folia alterna. Limbi adulti ad 13^{cm} longi cum petiolis ad 20^{cm} longis in sicco tenuiter membranacei pellucidi. Pedunculi circiter 4^{cm} longi. Amenta in sicco membranacea

2^{mm} crassa. Bractea ovariumque glandulis pallidis conspersa.—Species *P. Gardnerianæ* Miq. affinis.—Laguna de Ayarza, Depart. Jalapa, alt. 8,000^{ft}, Sept. 1892, Heyde & Lux, no. 3,834.

Var. *β.* **minor** C. DC.—Foliis minoribus, limbis ad 9^{cm} longis in sicco paulo firmioribus, petiolis ad 6^{cm} longis, amentis foliorum limbos superantibus.—Estanzuela, Depart. S. Rosa, alt. 2,500^{ft}, Aug. 1892, Heyde & Lux, no. 3,835.

Peperomia Guatemalensis C. DC.—Foliis breviter petiolatis subrhombeo-lanceolatis basi cuneatis apice obtusiusculis supra glabris subtus pilosulis 5-nerviis nervis externis subtilibus, amentis terminalibus vel axillaribus pedunculatis glabris folia pluries superantibus densifloris, bractea elliptica paulo supra medium peltata subsessili, ovario rhachi impresso obovato apice oblique stigmatifero, bacca globosa glabra.—Herba erecta circiter 12^{cm} alta inter muscos crescens, caulibus pilosulis inferne radicantibus. Folia inferiora opposita superiora alterna. Limbi in sicco membranacei subopaci pellucido-punctulati 3–5^{cm} longi 1.5–2^{cm} lati. Petioli ad 4^{mm} longi. Pedunculi ad 8^{mm} longi. Amenta glabra ipsa matura circiter 10^{cm} longa in sicco 1.5^{mm} crassa.—Species *P. Bauerianæ* Miq. proxima.—Acatepeque, alt. 4,300^{ft}, March 1892, J. D. S., no. 2,587.

Peperomia Santa-rosana C. DC.—Foliis quaternis brevissime petiolatis e basi cuneata obovatis apice emarginatis utrinque glabris 5-nerviis, amentis terminalibus pedunculatis ipsis adultis folia pluries superantibus glabris, bractea orbiculari subsessili, ovario emerso in apice obtuso oblique stigmatifero, stigmate minuto.—Herba erecta glabra. Caules in sicco complanati, amentiferi circiter 2^{mm} crassi, steriles ad 6^{mm} crassi. Limbi caulium fertilium 2^{cm} longi 13^{mm} lati, sterilium ad 3^{cm} longi et ad 15^{mm} lati. Petioli 2–3^{mm} longi. Pedunculi ad 2^{cm} longi. Amenta florentia ad 13^{cm} longa et ad 2^{mm} lata.—*P. obcordatæ* Presl verisimiliter proxima sed foliis majoribus et minus profunde emarginatis ab ea discrepans.—S. Rosa, alt. 3,000^{ft}, June 1892, Heyde & Lux, no. 3,454.

Pilea Pansamalana.—Suffrutescent (1.5–2^{ft}); branches several from base, decumbent, simple, terete: stipules minutely triangular; leaves glabrous, punctate and lineolate above, venose beneath, subopposite nerves remote from base and vanishing below apex, crenate-serrate except at base, dimor-

phous and very unequal in the pair; the larger lanceolate to rhomboid-elliptical (18–36×6–10^{l}), tapering each way from middle, apex obtuse, base acutely narrowed into short (2–3^{l}) petiole; the smaller obovate or rhomboid-orbicular, apex rounded, base acute, petiolate: diœcious; pistillate cymes (the only seen) not exceeding petiole of larger leaves, pedunculate, divaricate, flowers pedicellate, interior segment of perianth subequalling the others and minutely cucullate, twice exceeded by staminodes, half as long as obliquely oval (0.75^{l}) and pubescent achenium.—Nearest to *P. dendrophila* Miq.—On decayed mossy trunks of trees, Pansamalá forest, Depart. Alta Verapaz, alt. 3,800^{ft}, June 1886, von Türckheim, no. 939.

Pilea riparia. — Stem repent, elongate, ligneous, simple branches ascending (6–12^{in}): stipules minute, deltoid; leaves glabrous, thick, subentire, 3-nerved from base to middle on upper surface and nearly to apex on reticulated lower surface; the larger in the pair oblong-elliptical (3.5–4×1.75^{in}), long-acuminate, tapering gradually to short (2–4^{l}) petiole; the other a fourth smaller, obovate-elliptical, abruptly acuminate; cystoliths of upper surface densely stellulate-punctiform, of lower minutely linear, of margins large and fusiform: diœcious; staminate cymes not seen; the pistillate pedunculate, little exceeding petiole, divaricate; interior segment of perianth lightly gibbous on back and scarcely exceeding the others, staminodes as long, oval achenium thrice longer (0.5^{l}) and smooth.—Nearest to *P. marginata* Wedd.—Specimens of this, as well as also of the other proposed new species except *P. irrorata*, have been compared by Dr. Taubert in the Berlin Herbarium. I am likewise indebted to him for the identification of several other *Pileæ*, difficult of determination without the aid of authenticated material.—On rocks in a stream, Pansamalá, alt. 3,800^{ft}, August 1886, von Türckheim, no. 1,040.

Pilea irrorata. — Herbaceous; stem shortly rooting at base, stout, simple or forked (1–2^{ft}): stipules elongate-triangular (2–3^{l}), persistent; petioles long (1.5–3.5^{in}), canaliculate, dilated at base and apex; leaves membranaceous, smooth, ample (6–9×2–4^{in}), elliptical, caudate-acuminate, obtuse, base acuminate, the opposite uniform and nearly equal, sinuate-serrulate above middle, 3-nerved from insertion to apex, transverse veins distinct and subparallel, above punctulate and toward base lineolate, cystoliths scarcely present beneath:

monœcious or diœcious; cymes unisexual, subsessile, bracteose, densely flowered; the staminate semi-globose (5–8[l] high), axes explanate, fascicled pedicels filiform (3[l]), perianth before anthesis obpyramidate (0.75[l]) with inflexed cucullate tips, rudimentary ovary nearly obsolete; pistillate cymes smaller and glomeruliform, staminodes most minute, exterior segments of perianth small.—Distinguished chiefly by the long pedicels of staminate flowers.—Pendent from irrigated cliffs of the Barranca of Rio Samalá, Depart. Retalhuleu, alt. 1,700[ft], April 1892, J. D. S., no. 2,751.

Pilea pleuroneura. — Rooting at woody base, ascending (12–18[in]), branching composite, branchlets complanate and alate, glabrous, glandulose: stipules minutely semi-obicular; leaves distichous, subsessile, lanceolate (7–9 × 1.5–2[l]), the smaller in the pair half as long and elliptical, apex obtuse, 2–5-crenate, the inferior half entire and cuneate, penninerved, the stronger 7–9 nerves ascending to margin, veins immersed, cystoliths present only on upper surface and linear: diœcious; staminate flowers not seen; the pistillate fasciculate at apex of longer (1–1.5[l]) peduncle, short pedicels recurved, cucullate segment of perianth twice exceeding the others, achenium obliquely ovate (0.5[l]) and rubro-punctate.—Pansamalá, alt. 3,800[ft], June 1885, von Türckheim, no. 754.

Pilea senarifolia. — Herbaceous, glabrous; stem repent, branches ascending (12–18[in]), opposite or verticillate branchlets 6-alate: stipules scarious, minutely oblong, persistent; petioles short (0.5–1[l]), induplicate; leaves 6-verticillate, unequal, obovate-spatulate to obovate-cuneate (3–5 × 1.5–2[l]), coarsely incurved-crenate above middle, penninerved, crenations and nerves three to a side, upper surface transversely striolate with fusiform cystoliths: monœcious; unisexual cymes from adjacent axils in the whorl; the staminate twice to thrice exceeding petiole, 2–3-flowered, peduncle and pedicels subequal, perianth in præfloration globose (1[l]), tips of segments pileate, rudimentary ovary none; pistillate cymes minute, few-flowered, segments of perianth somewhat unequal.—Anomalous by leaves all strictly verticillate.—On old trunks of trees, Chiul, Depart. Quiché, alt. 8,000[ft], April 1892, Heyde & Lux, no. 3,145.

Pilea Quichensis. — Herbaceous; stem simple (20–30[in]), slightly pubescent, sulcate: stipules deltoid (1.5[l]), decidu-

ous; petioles slender (1–2^{in}), triquetrous by produced nerves of leaf, estriolate; leaves glabrate, the opposite somewhat unequal, obliquely oblong-elliptical (4–6.5 × 1–2^{in}), prolonged to a slender (6–9$^{'}$) and sharply serrate tip, base acute and induplicate, serrate throughout, 3-nerved to apex, exterior veins all equal and ascending to margin of incurved crenations, interior veins anastomosing, veinlets finely reticulating, pellucid, upper surface striate with small cystoliths, the lower glaucous: monœcious; staminate cymes geminate, shorter than petiole (5–8$^{'}$), peduncle bifurcate, flowers single and racemose or few-clustered on long spreading branches; perianth in aestivation oval (1$^{'}$) and exceeding pedicel, obtuse segments incrassate at the base and back, stamens twice longer, rudimentary ovary minutely subulate; pistillate cymes from uppermost axils much smaller, in anthesis conglomerate, broadly cucullate segment of perianth thickened and exceeding the scarious exterior ones, ovary slenderly elliptical.—Intermediate between *P. multiflora* Wedd. and *P. falcata* Liebm.—San Miguel Uspantán, alt. 6,500^{ft}, April 1892, Heyde & Lux, no. 3,147.

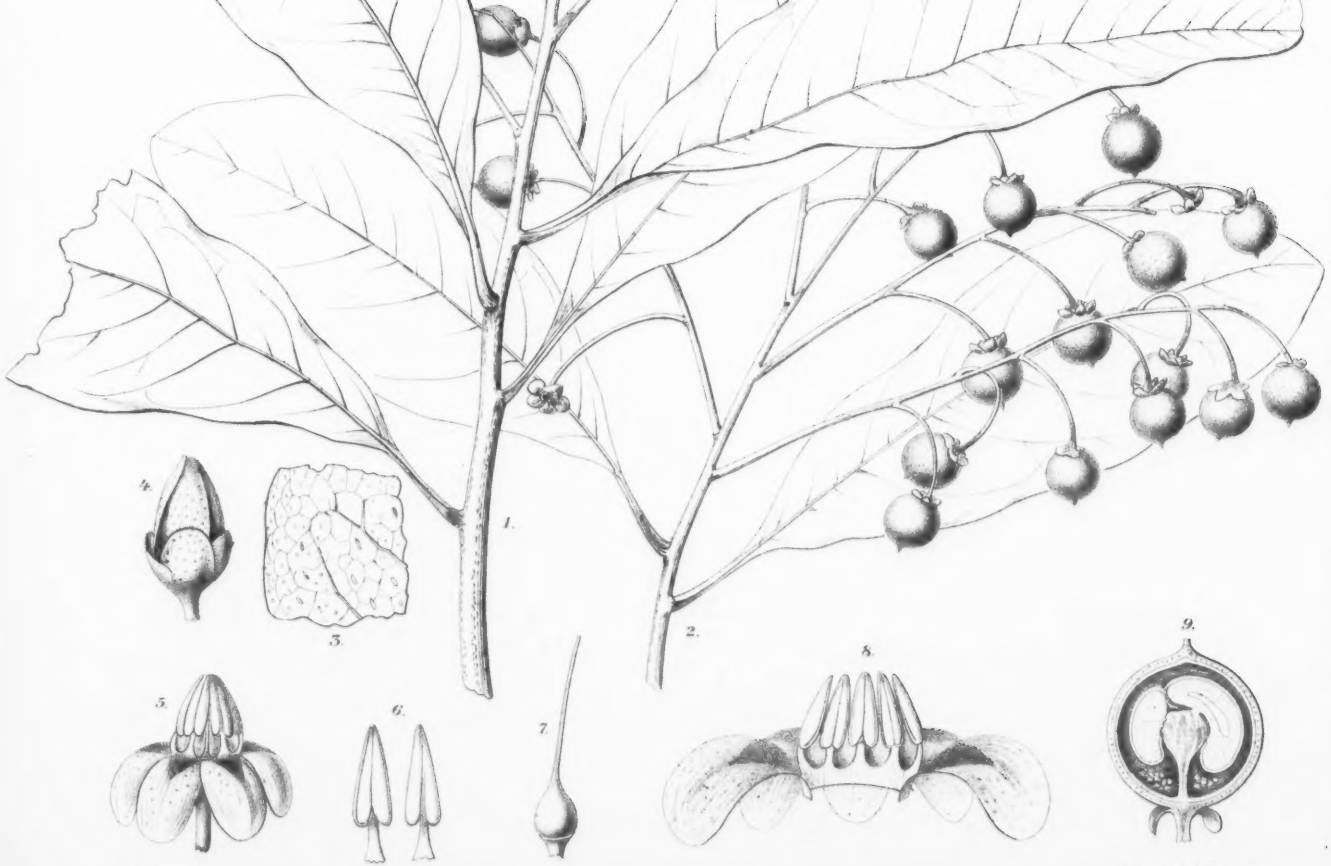
PINUS DONNELL-SMITHII Mast., Botan. Gaz. **16:** 199.

EXPLANATION OF PLATE II.—Fig. 1, portion of branch with leaf-scars, tufts of leaves, primordial leaves and male flowers, nat. size.—Fig. 2, tuft of leaves with sheath of leaf-scales at the base.—Fig. 3, portion of leaf magn. 4 times, showing lines of stomata and serrations at the edge.—Fig. 3^{a}, section of leaf magn. 50 diam., showing epiderm, two layers of hypo- or exoderm, stomata, mesophyll with sinuous cells, a triangular pericycle with well marked endoderm and a branched fibro-vascular bundle with phloem towards the dorsal side of the leaf and xylem towards the upper edge. Between the two masses of xylem are several large libriform cells.—Fig. 4, primordial leaf or "*squama fulcrans*" magn. 4 diam.—Fig. 5, male flower isolated magn. 2 diam.—Fig. 6, stamen from the front and from the back magn. 6 diam.—Fig. 7, stamen from the side magn. 6 diam.—Fig. 8, pollen grain magn. 200 diam.—Fig. 9, ripe cone.—Fig. 10, longitudinal median section of cone.—Fig. 11, detached scale of cone showing apophysis and umbo.—Fig. 12, scale of cone seen from the side.—Fig. 13, young seed.

Dioscorea dieranandra. (§ ALLACTOSTEMON Griseb. in Fl. Bras.)—Glabrous in all parts: leaves orbicular-cordate (5–9 × 4–7^{in}), abruptly acuminate, membranaceous, pale beneath, pellucid-lineolate, nerves 7–9, the exterior pair 1-furcate, midrib somewhat exceeding stout petiole and thrice longer than approximate basal lobes, sinus broad, transverse veins distinct: spikes solitary, or the fertile 3–5-fasciculate and occasionally furcate, filiform (12–17^{in}), rachis angulate, bracts broadly oval and long-acuminate, flowers solitary and sessile;

sterile flowers somewhat exceeding bract, perianth ¾-partite, semi-erect segments oblong-lanceolate (1.5^{l}), distinct stamens a third as long and exceeded by subulate staminodes, anthers bipartite-locular and shorter than filament, rudimentary ovary none; fertile flowers less approximate, segments of perianth linear (1.5^{l}) and equalling tube and bract, connate styles very short (0.5^{l}) and twice exceeding effete stamens, deflected stigmas bilabiate: capsules not seen.—The character is drawn from specimens collected at two localities and respectively of different sexes, but matching in form and anatomy of foliage; in each the flowers are of novel structure.—Cerro Gordo, Depart. S. Rosa, alt. 3,500^{ft}, Sept. 1892, Heyde & Lux, no. 3,869; Rinconcito, Depart. S. Rosa, alt. 4,000^{ft}, Nov. 1892, Heyde & Lux, no. 4,359.

Baltimore, Md.



C.E. Faxon, del.

B. Meisel, Lith. Boston.

ARDISIA PASCHALIS, n. sp.

W. C. Smith, del.

PINUS DONNELL-S

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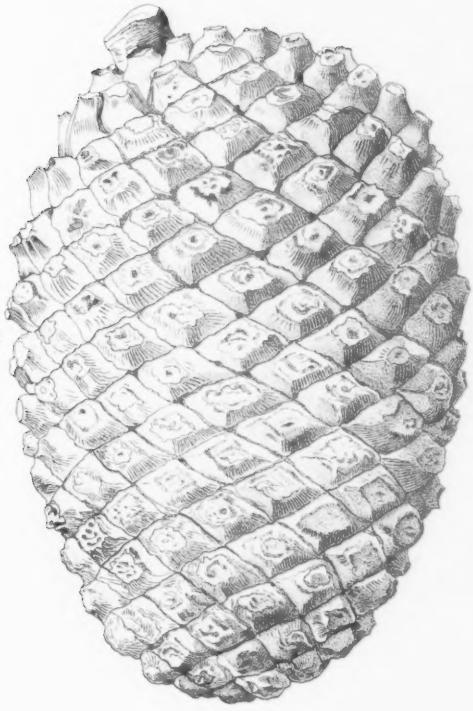

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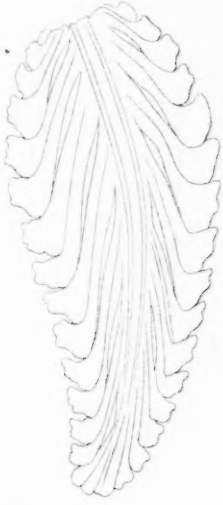

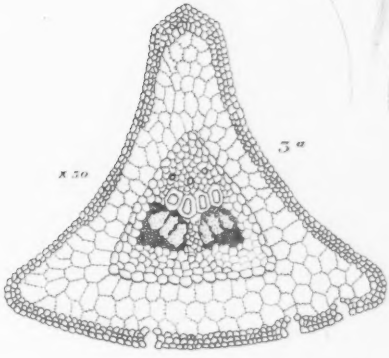

x 30

3a

B. Matsel, lith Boston.

NELL-SMITHII. Mast.

On the color description of flowers.

J. H. PILLSBURY.

In no respect is the description of a plant more often doubtful than in the color assigned to the flowers, especially if any trace of violet be present in the coloring. It is not at all uncommon to hear some one, reading the description of a flower, exclaim regarding the color, "that is wrong." During the past ten years I have noted with much interest the different expressions used by students in my classes to describe the color of some of our most common wild flowers. As a rule, I have found that young ladies are much more explicit in their description of the color of a flower than the young men of equal intellectual advancement. This is probably not due to a keener color sense, but to the possession of a fuller vocabulary of color terms. In consequence of this fuller vocabulary, the young lady seeks to express smaller differences of color. I have not found, however, that she is more accurate in her description of the color in question. Indeed, it has often seemed to me that the smaller vocabulary has led to a more careful discrimination and a more correct discernment of the components of the color. What we most need is not a fuller vocabulary but a more accurate use of the vocabulary we now possess. It is no doubt a fact that an occasional source of confusion in the description of floral color is a more or less feeble sense in regard to some one color. But this difficulty can not be of sufficiently frequent occurrence to be a serious source of confusion. The percentage of persons who are either color blind or possess only a feeble sense for some one color is so small that there is certainly likely to arise no very frequent trouble from such a source.

The confusion of color description arises mainly from two clearly discernible sources both of which, it seems to me, we may reasonably hope to be able to remove.

The first of these sources needs hardly more than the mere mention to be recognized by every botanist. I refer to the fact that we have absolutely no recognized standards of color, and no generally accepted plan of color nomenclature. To say nothing of the conflicting theories of color which are still in vogue, each of which has its adherents, nearly every writer

on color, who has made the least attempt to suggest a scheme of colors to be used as a basis of color work, has proposed at least one color which is peculiar to himself, either in name or in quality; and in only a few instances has any exact definition been suggested even for a single color. Where one writer has used the term red to designate a primary color, another has used the term vermillion. The former term, without any limitations, will include a variety of hues; and the latter is by no means as definite as might be supposed, since pigments called vermillion by different manufacturers vary greatly in hue. In the few cases in which a particular color term has been proposed and designated by some such definite limitations as the wave length of its vibrations, it has been only for single colors. No series of colors has been proposed as standards upon which a scheme of nomenclature might be based. The result has been the same as before. No remedy for the confusion that prevails is offered.

The second source of confusion is in part dependent upon the first and yet is a very distinct source of trouble. It is the lack of correct color education and ability to correctly analyze color impressions. It has been maintained that the eye does not analyze color impressions. In a sense this is undoubtedly true; but there is also a sense in which it is true that the eye does analyze color. When we look at any patch of color which is not one of the pure spectrum hues, the eye does not see the two colors which would produce that color impression. What we do see is the result of a very complex mixture of light waves of a great variety of wave lengths impinging upon the retina, and the impression is generally due to a preponderance of waves of a rate lying between those of some two well defined colors. Perhaps this can be made clearer if we take an illustration from musical sounds. Suppose the ear to detect a sound having a pitch somewhere between C and D. Now, although the ear does not hear either C or D in that sound, it may be able to determine that the sound lies somewhere between C and D in pitch, and that it lies nearer C than D. Just this same sort of discrimination we need to have taught with regard to color, and especially with regard to the color of flowers. When once we have agreed upon a series of standards of color, this education will be not only possible but easy. With a reasonable amount of training it will not be found difficult to locate any color between two colors of the solar spectrum.

It was these difficulties to which I have above referred in the use of color terms, and certain anomalies which I encountered in the course of a series of physiological investigations regarding color sense, which led me to give my attention to the selection of a system of color standards taken from the solar spectrum, the only source of authority in color. (See *Science* for June 9th, 1893.)

With these standards to work from, I undertook to determine the color analysis of certain of our common flowers. The following results will, I think, be interesting to botanists. The numbers given indicate per cent. of color required to produce the hue of the flower.

The symbols used in the formula stand for the six spectrum colors, viz., red, orange, yellow, green, blue and violet with white and black (N for *niger* being used to avoid the repetition of B).

Common forsythia, F. viridissima: pure spectrum yellow.

Fringed polygala, P. paucifolia: R 48, V 52.

Wistaria, W. frutescens, wings: R 11, V 89.

" " " , standard: R 9, V 79, W 12.

Flowering quince, Cydonia japonica: R 95, V 2, W 3.

Wild cranesbill, Geranium maculatum: R 28, V 66, W 6.

The variations of color in the early summer foliage is also interesting. The following analyses are for the upper side of fresh and well developed healthy leaves. It is not impossible that a little attention to these variations in the color of foliage on the part of artists would save us the annoyance of some of the abominable green which we so often see in the pictures of artists of good reputation.

White oak: Y 7.5, G 11.5, N 81.

Apple: Y 5, G 13, W 2, N 80.

Copper beech: R 17, V 2, N 81.

Hemlock: Y 2, G 9, N 89.

White pine: Y 2.5, G 11, N 86.5.

White birch: Y 5.5, G 11.5, W 1, N 82.

Hornbeam: Y 5.5, G 12.5, N 82.

Shagbark hickory: Y 4.5, G 9.5, N 86.

These analyses were made in a moderately strong diffused light with Maxwell discs of the standard hues referred to above. The discs were combined upon a color wheel giving sufficiently rapid rotation to blend the colors smoothly and give an even surface of color with which to compare the

flower or leaf as the case might be. The analyses can be easily made by any one and after a little practice with a good degree of accuracy. The objects to be gained by such analyses are twofold, viz., the determination of floral color with something like accuracy and the development of a keener perception of color relations. Discs in these standard hues can be obtained at a moderate price and they can be used on any apparatus for rotating the Maxwell discs.

It has already been intimated that greater confusion prevails with regard to violet than any other color. By some writers purple has been used to designate the most refrangable color of the solar spectrum. This is very unfortunate and has led to a great many errors that are exceedingly difficult of correction at the present time. All of the numerous hues to which the term purple is properly applied are combinations of red and violet, often modified by the presence of some white light and almost always with more or less of black, thus forming what is called a broken purple. In the above analyses we have in the fringed polygala the red and violet in nearly equal proportions. The color of the flowering quince is slightlyviolet red modified by the presence of a small portion of white, On the other hand the color of the wistaria is a reddish violet, in the wings modified by white in the standard. The cranesbill is a still more red violet, i. e., it comes nearer to a purple.

The colors assigned to the flowers whose analysis I have given above in two of the botanical text books most commonly used in our schools are as follows: under the description of Polygala paucifolia Wood says, "flower purple" while Gray says, "flower rose purple." Concerning the wistaria both Wood and Gray say, "flower lilac purple." Wood describes the flower of Cydonia Japonica as "crimson." Gray gives the color of Geranium maculatum as "light purple" while Wood calls the same flower simply "purple."

Springfield, Mass.

Archenema, protonema and metanema.

CONWAY MACMILLAN.

It is intended in this brief paper to call attention to certain gametophytic differentiations and possible homologies which, while not by any means everywhere overlooked, have not, perhaps, received the proper accentuation in current botanical thought. At the outset it may be well to attempt to give a definition of a gametophyte. As understood by the writer, this term does not by any means properly apply to every plant structure that produces gametes. The Cœloblasteæ, for example, mature undoubted eggs and sperms, but the plant body thus functioning can scarcely be termed a gametophyte. A gametophyte can be defined only in terms of a sporophyte held in contradistinction with it. Therefore it is only in that group of plants that I have named the Sporophyta[1] that gametophytic structures may be rightly discerned. It is inadmissible to apply the term to any plant below the position of Œdogonium (or Ulothrix?). A gametophyte, then, is a structure derived directly or indirectly from a sporophytic spore or its analogue, and itself capable of producing, directly or indirectly, a gamete or gametes. The algæ Œdogonium and Coleochæte, "leafy moss plants," fern prothallia, the endosperm of Araucaria, the pollen tube of Burmannia and the embryo-sac nuclei of Narcissus are types of gametophytes. The definition, it will be observed, takes note both of formation and of function. In the case of each a reservation must be made, for gametophytes may arise directly by propagative methods, as in the breaking up of a moss protonema, or by the activity of certain bodies (the homologies of which may be with multiple spores rather than with propagative structures), such as the gemmæ of Aulacomnium and Lunularia. And on the other hand, through apogamy, as in *Todea africana*, *Pteris cretica* and a few other ferns, or in some less aberrant manner, the gametophytic structure may fail to produce gametes.

Thus defined, the gametophyte may be isolated for study in any species where it occurs. It should be noted, perhaps,

[1] Metaspermæ of the Minn. Valley 20. 1892.

at this point, that the interlocking and interdependence of sporophyte and gametophyte is such that, wherever they alternate, certain structures appear, under a rigid classification, to be included in both categories. The same cell may be morphologically sporophytic but physiologically gametophytic, or *vice versa*. This is true of the two unicellular stages which serve to distinguish so sharply the higher plants from the higher animals (in which there is but one unicellular stage in the life-history of the organism). The spore, since it is structurally part of the sporophyte, must be grouped by morphology with the other sporophytic structures. But, since the spore is also the first stage of the gametophyte which becomes elaborated through development, it must, by the classification of physiology, be grouped with the gametophyte. The same paradox is to be noted for the fecundated egg. It is quite as distinctly gametophytic from a morphological point of view, but in the physiological sense it is sporophytic.

A consideration of the gametophyte of the Muscineæ reveals to the student its comparatively high structural rank among gametophytes. This high rank is evidenced most particularly by its developing not as a continuous structure with but one developmental stage, but as a discontinuous structure with two distinct developmental stages. While gametophytes above and below the Muscineæ may be considered as generally monomorphic, the gametophyte of the Muscineæ is very constantly dimorphic. It appears in two readily separable stages of certainly deep phylogenetic meaning. The first of these stages is known as protonema. For the second I propose the term, *metanema*. The gametophyte of any hepatic or moss may then be considered as distinguishable into protonema and metanema. Protonemata may be compared with metanemata or with other protonemata, and conversely. An examination of protonemata from the point of view of comparative anatomy shows that they exhibit much power of evolution and improvement. Structurally either filamentous or thalloid, they exhibit much variety, and increase in size and complexity as one passes from the lower Hepaticæ to Hypnum and Bryum. Physiologically they show, in many of the true mosses, wider capacity than in the liverworts, this being particularly evidenced by increase of propagative power with perfecting of propagative apparatus. The protonemal

tubers of *Barbula muralis* and *Trichostomum rigidum* are examples of this increase; and, of a quite different category, the remarkable formation of *protonemal chlamydospores* by *Funaria hygrometrica* should be mentioned.

Similarly one notes in metanemata much development in form and function, as the ascending series from Riccia and Anthoceros is followed. The metanema is, as has been conjectured, very probably a highly specialized gametophore which has assumed in connection with its particular reproductive functions many improvements in vegetative function with their attendant morphological developments. In such plants as Preissia or Conocephalus, where the metanema is differentiated into vegetative and reproductive branches, one sees a reiteration of the process by which the metanema was itself differentiated from the protonema.

The typical metanema of the Muscineæ undergoes a vegetative evolution in two directions. It appears either as thallus or as leafy stem. In the Muscineæ, as far as I know, there is no truly filamentous metanema. The male prothallium of Salvinia, and pollen tubes in general—if they be metanemata at all—would furnish examples of the filamentous type. It is perfectly apparent however that not all of the thalloid metanemata of the Muscineæ are of equal rank. The same is true of the leafy-stemmed metanemata. In the Hepaticæ, where both thalloid and leafy-stemmed metanemata are to be found, some thalli may be regarded as original while others may be considered as derived from leafy stems. Marchantia, for example, may, with much reasonableness, be derived from a Jungermannia archetype; while Anthoceros, on the other hand, may be derived directly from a Coleochæte-like archetype. The close genetic union of Marchantia with Riccia through Boschia and Corsinia, argued by Leitgeb[2] principally upon the basis of sporophytic homologies, is not perhaps to be considered as fully proved. If, on the contrary, Marchantieæ are to be considered rather as reduced Jungermannieæ, the Marchantia thallus may be defined as secondary. Thalli may therefore arise primarily by the evolution of protonemal branches or secondarily by the reduction of a leaf-bearing axis. The same suggestions apply to leafy-stemmed metanemata. They may, like Lejeunea, be considered as having arisen from thalli the margins of which have become dissected;

[2] Leitgeb, Die Marchantieen 49. 1881.

or they may arise directly from protonemal structures, as in Buxbaumia.[3]

One may then classify the metanemal structures of the Muscineæ thus:

Metanema of Muscineæ { Leafy stems { Secondary leafy stems. / Primary leafy stems. ; Thalli { Secondary thalli. / Primary thalli.

It is probable that neither in the Hepaticæ nor in the Musci is there any gametophyte that is not susceptible of division into protonema and metanema. It has been affirmed that Frullania, Anthoceros and a few other Hepaticæ develop directly from the spore as monomorphic structures (Nees ab Esenbeck), but this is not borne out by the researches of Leitgeb[4] who figures for Anthoceros at least a well-marked protonema. And for Frullania and its allies among the foliose Jungermannieæ, while Hofmeister believed that the protonema might be suppressed, the researches of Grönlund[5] have well demonstrated that the protonemal structure is constantly present in one form or another. Leitgeb himself concludes that the protonema is a normal stage for Frullania, Radula and the rest.[6]

Below the Hepaticæ there are undoubted gametophytes without any marked differentiation into protonema and metanema and others in which the differentiation is a matter of grave doubt. Of the first group, Œdogonium and Bulbochæte may be cited; of the second, Chara, Tolypella, Lychnothamnus and their allies. For the gametophytic structure that does not show any differentiation into protonema and metanema and stands lower than the hepatic gametophyte, I propose here the name of *archenema.* The Coleochæte thallus is an example of typical archenema. The gametophyte of the Characeæ is as certainly archenema upon the view that the so-called pro-embryo is an aposporous sporophyte.[7] If however the pro-embryo be taken for protonema and it be assumed that the sporophyte is altogether suppressed, then certainly the mature Chara plant must be classed as metanema.

[3] Goebel, On the simplest form of moss. Ann of Bot. **6**:355. 1892.
[4] Leitgeb, Die Anthoceroteen. 20. *pl.* 1. 1879.
[5] Grönlund, Mem. sur la germination de quelques hépatiques. Ann. Sci. Nat. Bot. IV. 1:
[6] Leitgeb, Die foliose Jungermannieen 63. 1875.
[7] Vines, The pro-embryo of Chara. Journ. of Bot. 1878.

Three structural categories of gametophytes have now been established in this discussion; archenema, protonema and metanema. The very important question then arises:—what are the homologies of the fern prothallium? It is apparent that there is no *á priori* reason why it may not be any one of the three. In Coleochæte the gametangia are borne upon archenema; in Buxbaumia at least the antheridia are produced upon protonema (Goebel), while in the great majority of Hepaticæ and Musci the gametangia are altogether metanemal in their origin. The fern prothallium might then be considered as a developed Coleochæte-like structure which has not passed through the differentiation into protonema and metanema; or it may be regarded as a thalloid protonema, the metanemal companion stage of which has been suppressed by reduction; or again as a metanema, the embryonal protonemal stage of which has disappeared. It will be seen at once that the correct interpretation of the facts in the case is of great importance. Especially, in view of the fact that there is a modern effort to reach the conclusions of fern phylogeny from the gametophytic as well as from the sporophytic side of the organism, is it imperative that the three possibilities be held distinctly in view. Indeed it would seem as if the criticism here undertaken might indicate the necessity for a revision of some important conclusions which have been put forth recently by students of the Archegoniatæ. For example, I am here strongly inclined to criticise the position maintained by Campbell[8] that "the prothallium of Hymenophyllum corresponds not merely to the protonema of a moss, but to the protonema *plus* the leafy plant." It is not that the position may not be a sound one (for the prothallium may indeed be archenema), but because the verdict should as yet be the Scotch verdict. And especially, in view of the very able and convincing argument of Campbell in favor of considering the eusporangiate ferns as basal and derived from the vicinity of Anthoceros with its undoubted metanema, must one hesitate to regard the prothallium of Hymenophyllum or any other fern as archenemal. But if not archenemal it must apparently correspond with either protonema or metanema. There is of course the possibility of arguing the derivation of the fern prothallium from archenema, and its independent differentiation into protonemal and metanemal stages. The

[8]Campbell, On the affinities of the Filicineæ. Bot. Gaz. **15**: 1. 1890.

prothallia of the Polypodiaceæ, Cyatheaceæ and Schizæaceæ, in which the first product of germination is a filamentous structure afterwards developing into a cordate thallus, or the rather poorly understood prothallia of the Ophioglosseæ may be considered as dimorphic gametophytes and interpreted accordingly. It will be seen, however, that protonemal and metanemal stages would in such case be analogous (not homologous) to the protonema and metanema of the Muscineæ, offering a case of parallel development under similar physiological conditions. And under the methods of classification proposed it is apparent that the conclusions of Goebel[9] can not yet be accepted. As to whether "we may regard as the starting point for Bryophyta and Pteridophyta alga-like forms consisting of branched filaments," judgment must, I believe, be suppressed for the present. It must first be determined whether the prothallium of the fern which is to be taken for the basal fern corresponds with algal archenema or with the protonema or metanema of the Muscineæ.

Conclusion.—The gametophytic structures below the ferns may be described under the heads of archenema, protonema and metanema.

It has not yet been clearly shown with which of these three series the fern prothallium is homologous.

Until the exact homologies of the fern prothallium are discovered, under such a classification it will not be possible to make full use of gametophytic stages in fern phylogenesis.

Phylogenetic argument based upon previous interpretations of the fern gametophyte may be considered as open to possible emendation.

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[9]Goebel, Zur Keimungsgeschichte einiger Farne. Ann. Buitenz. 7: 74. 1887.

Mutualistic symbiosis of algæ and bacteria with Cycas revoluta.

ALBERT SCHNEIDER.

WITH PLATES III AND IV.

Recently my attention was directed to the tubercle-like growths on roots of *Cycas revoluta*. A cursory examination showed that they were infested by a nostoc. In my search for the literature on the subject I found few and incomplete references. Between 1870 and 1873 Reinke discovered parasitic Nostocaceæ in species of Gunnera and Cycas. Janczewski discovered parasitic algæ in mosses, Cohn in Lemna, Kny in Florideæ and Strasburger in Azolla.

Reinke is to my knowledge the only person calling attention to an Anabaena found parasitic in a specialized parenchyma layer of Cycas roots. His incomplete though exact description has induced me to study the subject more closely.

Cycas root tubercles, which are simply short somewhat enlarged dichotomously branched rootlets, are quite common on most of our cultivated cycads. They occur on young as well as on old plants. The youngest plants at my disposal were about two years old. Only a few tubercles were present. A large, well nourished plant about twenty-four years old had many tubercles. They were most numerous near the surface of the soil; a few were wholly above and some were found a foot or more below the surface. Usually they are formed from the ends of rootlets, sometimes from the side of root branches, especially the single unbranched tubercles. In position they show evidence of negative geotropism. This is very marked in tubercles near the surface of the soil. Branching is always dichotomous (see plate III, fig. 3). Branches are short and somewhat spindle-shaped, the ends being bluntly rounded. Why they should branch dichotomously is interesting. It is probably a form of atavism showing the relation of cycas to the vascular cryptogams. Likewise the occasional dichotomous branching of leguminous tubercles may indicate a descent from cryptogams.[1] As to color one may readily distinguish

[1] It may be mentioned here that the relative positions of the phloem and xylem in the vascular system of leguminous tubercles corresponds to that in Cycas.

three kinds of tubercles. Those of a yellowish tan color, generally found above the surface, are devoid of the symbiotic algæ; the second variety, of a slightly darker tan and often greenish near the tip, always contain the algæ; they are the younger tubercles. The third variety, which also contain the algæ, are of a dark brown color and are older than the others. These three varieties are found on the same plant. In external appearance they resemble somewhat the tubercles of *Pisum sativum*. Morphologically they differ considerably. In pea tubercles the symbionts are surrounded by the vascular bundles while in Cycas the symbionts surround the centrally located vascular system. They resemble each other in their mode of branching.

Their mode of development is quite simple. Either the ends of rootlets branch dichotomously or they develop endogenously. It may be more correct to say that all tubercles develop like primary roots and that the lateral development is only apparent. That is the developing lateral root branch receives its tubercular peculiarity from the very start. The line of demarcation between rootlet and tubercle is very distinct and abrupt. The tubercle branch has about three or four times the dimensions of a rootlet of the same length.

On making a cross section of any part of the tubercle excepting the tip one can see with the naked eye a green circular layer about midway between the epidermis and bundle sheath. This is the alga-bearing layer. At certain points this green layer is discontinuous. This always occurs opposite outer lenticular structures which are quite common on the tubercles and are arranged in more or less broken rings. Having thus treated of the gross anatomy I shall next describe the minute anatomy.

A cross section shows six tissue layers. The first and outermost is the dermal layer of irregular corky cells several rows in thickness developed from a dermatogenic layer dividing tangentially. In the dermal layer are also included the lenticular structures consisting of enlarged irregular corky cells which do not seem to develop from any definite phellogenic layer. The cell walls of the dermal layer give to the tubercle its yellowish or dark brown color. The cells contain, besides the remains of nuclei and cytoplasm, various kinds of rhizobia in comparatively small numbers. The entire surface of rootlets, roots and tubercles is more or less covered by

rhizobia, bacteria, hyphal fungi and various species of algæ, the discussion of which will be taken up below. The second layer is the dermatogenic layer of tangentially elongated rectangular thin walled cells. The third layer is the subdermal parenchyma of large rounded cells with intercellular spaces and air conducting passages. Considerable starch is present and often oil globules are found toward the inner side where the most rhizobia and bacteria are also found. The fourth layer is of the most importance. It consists of two opposite rows of palisade cells. This layer is only present in tubercles bearing algæ and is formed from radially elongating parenchyma cells beginning near the apical area of the tubercle and extending near the point of separation between tubercle and rootlet. The two rows of palisade cells are separate or only loosely connected in the middle. The cells are thin walled, about two or three times as long as broad, with large nuclei suspended in a granular cytoplasm. The large intercellular spaces are entirely filled with algæ (*Nostoc* sp.?). Besides the granular cytoplasm, the cells contain starch, amyloplastids, sometimes oil globules, and a waxy body near the base. The fifth layer or parenchyma proper resembles the subdermal parenchyma. The cells contain much starch. Numerous cells entirely filled with a waxy substance are present. The sixth layer is the vascular system sheath consisting of modified parenchyma cells of several layers thickness. The vascular system need not be described as it is the same as that of the ordinary root.

A longitudinal section shows the presence of a rudimentary root cap consisting of elongated loosly connected cells covering more or less perfectly the rounded end of the tubercle. The apical area consists of small prismatic closely united meristem cells. The palisade cells do not extend quite to the apex. (See plate III, fig. 2.)

The exact cause of the development of these tubercles I am unable to state. That there is excessive metabolism is very evident from their appearance and the large amount of albuminous substances present. That the infecting algæ are not the cause of their development is shown by the fact that tubercles exist without the alga-bearing palisade layer. On making a comparative study of Cycas roots and tubercles I found the following differences: The dermal and apical area of tubercles contained more rhizobia and bacteria than

similar structures in ordinary roots and rootlets. Also the cytoplasm of tubercular cells is more granular, that is, it contains larger and more prominent dermatosomes, especially the palisade cells. It is very likely that whenever a certain amount of rhizobia and bacteria have infected the apical area of a certain rootlet, their irritating presence produces increased metabolism and rapid branching. Thus the increased number and size of the dermatosomes would be due to the rhizobia.

The question of the symbiotic relation of Cycas, algæ and rhizobia is very interesting and apparently rather complex. All soils, especially green house soils, contain rhizobia and other bacteria besides numerous algæ. These algæ are very common both in the soil and the vessels in which green house plants are grown. That they play an important part in binding the free nitrogen of the air has been conclusively shown by B. Frank. In examining carpellary and the rudimentary hypsophyllary leaves of Cycas it was seen that they often had a greenish coating consisting of algæ. The following genera were noted: Protococcus, Navicula, Chroococcus, Oscillaria, Glœocapsa, Ulothrix, Chlœosporium and Nostoc. Numerous rhizobia, bacteria and several species of hyphal fungi were also found. Among the rhizobia I could readily recognize *Rhizobium mutabile*,[2] *Rhizobium curvum*, and *Rhizobium Frankii* beside many, to me unknown, species of bacteria and cocci. Examination of the surface soil in which the plant grew showed a similar protophytic flora though in somewhat lesser abundance. The predominating types among the algæ seemed to be Protococcus and Nostoc. Among the rhizobia and bacteria I could find no predominating type.

Cross sections of tubercles showed that no algæ are inside the cells, while nearly all of them, especially those of the dermal layer, contained more or less rhizobia and bacteria. Parenchyma cells and bast cells of vascular system contained some rhizobia and bacteria. They seemed to be quite abundant in the apical area. Culture experiments developed three predominating types; a coccus, a probable rhizobium resemblimg *Rhizobium Frankii*, and a larger Indian club shaped bacterium resembling somewhat *Rhizobium mutabile* of *Trifolium repens* though smaller and of a more constant size and form (plate IV, figs. 6, 8).

[2] Bull. Torr. Bot. Club. **19**: 203. July, 1892.

Culture experiments were made with special precautions to prevent the introduction of bacteria, etc., everywhere present on the surface of both tubercles and roots. As a suitable medium a slightly acid agar-vegetable root extract was prepared. Tubercles of normal appearance were secured and carefully and thoroughly washed with plenty of hydrant water then quickly dried by means of blotting paper which had been passed through the flame of a Bunsen burner. A tangential section, including somewhat more than the dermal layer, was made down one side of the tubercle, then the tubercle was passed through the flame of the Bunsen burner so as to singe it thoroughly on all sides, and then broken (not cut) across. Inoculations were made from the broken surface farthest from the cut side. The inoculated tubes were placed in a dark chamber at the ordinary summer temperature (Ills.). In about six or seven days a small whitish growth was noticed in most tubes. Cultures made from the dermal and hypodermal parenchyma generally developed organisms resembling *Rhizobium Frankii* (plate IV, fig. 6), and I shall provisionally place them with that genus. Inoculations made from the palisade layer sometimes developed a coccus, more often there was no growth at all. As a rule there are no bacteria or cocci to be found with the infecting nostoc. Cultures made from the vascular system, especially near the apical area, generally developed the above mentioned *Rhizobium*, but more often a peculiar Indian club shaped organism (plate IV, fig. 8). I was unable to obtain absolutely pure cultures, but the two forms of bacteria (or rhizobia) described seemed to predominate. Cultures in which the rhizobium-like organism predominated finally took on a yellowish color. In this respect it resembled very much cultures of the rhizobia from the "Infektionsfäden" of *Melilotus alba* or *Trifolium pratense*. This organism resembles in appearance *Rhizobium Frankii* of *Phaseolus vulgaris* but differs in that it has cilia and is motile during its earlier life history.[3] Rhizobia and bacteria are not present in large numbers in any part of the tubercle. The question whether their presence is purely accidental or whether they live in active mutualistic symbiosis with Cycas could not be determined in the short time at my disposal. It is however quite certain that tubercles contain more bacteria

[3] Further experiments in regard to the determination of the rhizobia are now in progress.

and rhizobia than the normal root. It is also certain that there is greater cytoplasmic activity in tubercles than in the normal roots; this is shown by the greater abundance of albuminous substances present and the greater prominence of the cytoplasmic granules[4] (Dermatosomen, Plasomen, etc.) (plate IV, fig. 7).

As already stated the dark tan and dark brown tubercles always contain the infecting nostoc. It is generally taught that algæ can not develop in the dark. This is evidently not true as some of the nostoc-bearing tubercles are found as much as a foot below the surface of the soil. In fact tubercles wholly above the ground never contain the nostoc. That the nostoc is the cause of the development of the palisade layer is quite evident from their constant association.

The exact mode of infection is as yet undetermined. The nostoc no doubt enters the parenchymatous tissue of the tubercle through a break in the dermal layer soon after it begins to form. Why the nostoc should take up a definite position in the parenchyma midway between the dermal layer and vascular system sheath is as yet unexplained. The parenchyma cells nearest the nostoc appropriate the extra nitrogenous compounds stored by the infecting symbiont, this produces hypernutrition of the incipient palisade cells which elongate in a direction parallel to the easiest conductivity of nutritious substances, that is practically at right angles to the vascular system. They serve a similar function to palisade tissues in other positions, as in leaves. Nostoc, so to speak, takes the place and serves the function of chloroplastids in true palisade cells.

Nostoc is the only alga found in the tubercles. This is probably because it is more closely related to Schizomycetes than Protococcus or Ulothrix. It is therefore better adapted to lead a parasitic or a symbiotic existence. From a study of the infecting alga I conclude that it is *Nostoc commune.* Reinke placed it with Anabæna since he could detect no gelatinous imbedding material. I found however that they were quite firmly united to each other and to the palisade cells by a gelatinous substance. Cells are spherical, loosely united, forming longer or shorter strings. Division takes place at right angle to nostoc chain. Sometimes a cell divides parallel

[4] Contribution to the probable biology of Plasomen, Bull. Torr. Bot. Club **20:** 339. Oct. 1893.

to nostoc filament thus producing a new filament at right angles to the original. I could detect no difference in color and general behavior from nonparasitic nostoc cells. Heterocysts increase in number with the age of the tubercle. Sometimes, in very dark colored tubercles, heterocysts are present in greater numbers than the normal cells. I could detect no spore formation.

From the appearance of the host it seems quite evident that the infecting symbionts are far from harmful. The omnipresence and importance of schizophytic organisms in and on tissues of vascular cryptogams and gymnosperms is probably far from being overestimated.

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EXPLANATION OF PLATES III AND IV.

PLATE III.—Fig. 1. Portion of cross section of *Cycas revoluta* tubercle representing dermal (lenticular), dermatogenic, subdermal parenchyma, palisade, and parenchyma layers. Nostoc *in situ*.

Fig. 2. Portion of longitudinal section of tubercle showing apical area without the root cap. Beginning of palisade layer with a few nostoc filaments.

Fig. 3. Diagramatic section of tubercle, showing manner of branching and distribution of vascular bundles.

Fig. 4. *Nostoc commune*.

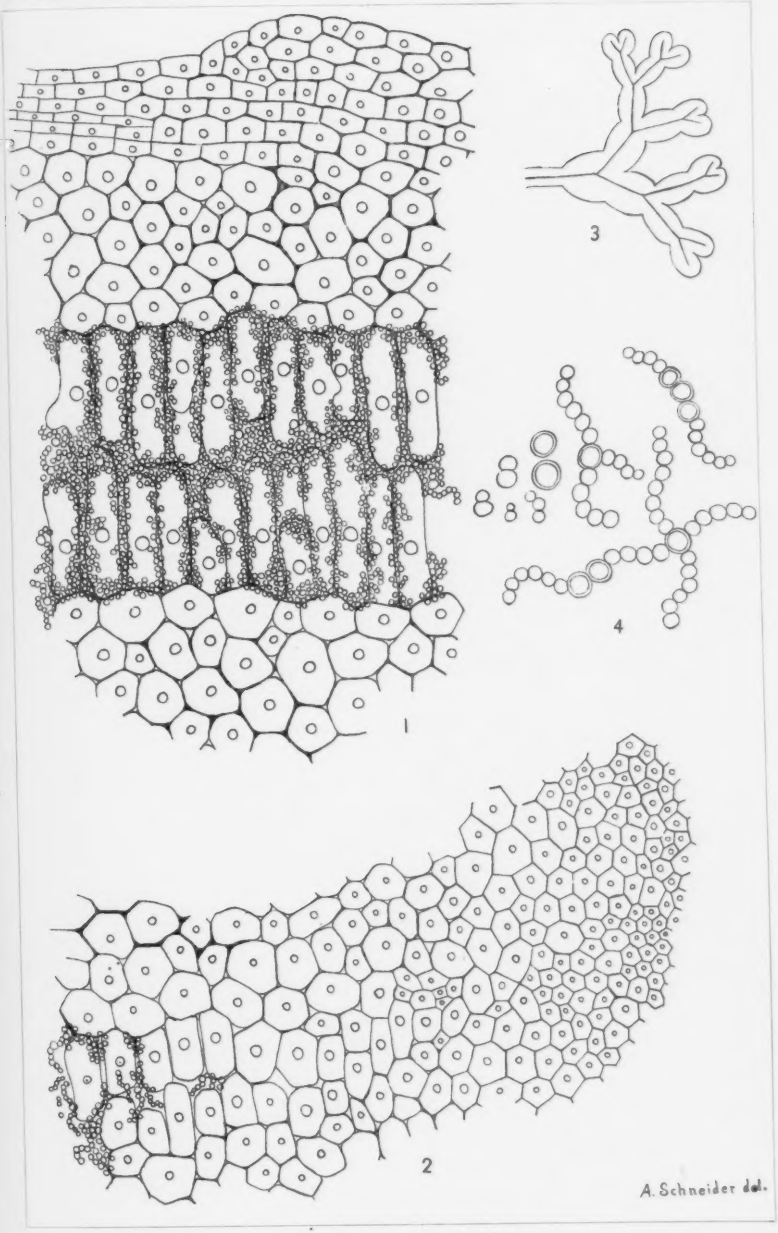
PLATE IV.—Fig. 5. Some of the parenchyma and palisade cells highly magnified showing reticulated structure of cytoplasm and nucleoplasm. Larger black dots in cells represent full grown plasomes or dermatosomes. Starch and resinous bodies in some of the palisade cells.

Fig. 6. *Rhizobium* sp. ? from dermal layer.

Fig. 7. Plasomes from palisade cells.

Fig. 8. Bacteria from parenchyma and vascular tissue

(Figs. 6, 7 and 8 very highly magnified.)



SCHNEIDER on SYMBIOSIS.

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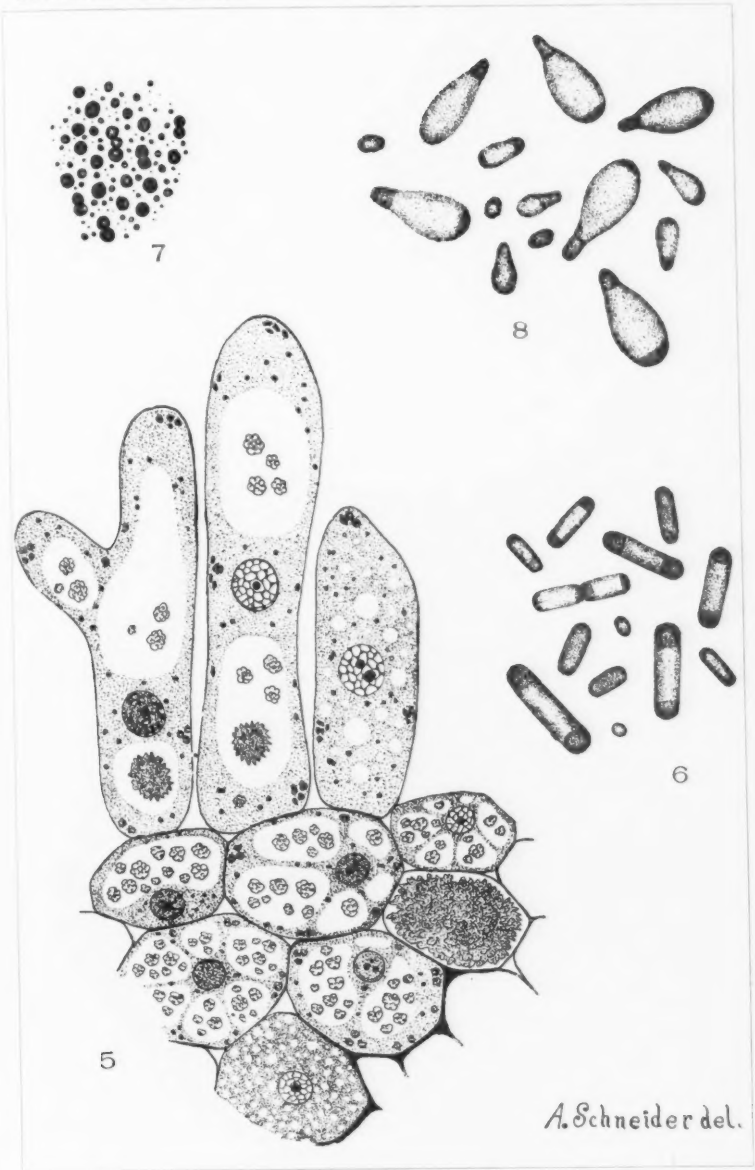

SCHNEIDER on SYMBIOSIS.

Botanical notes from Bainbridge, Georgia.

AUGUST F. FOERSTE.

Oaks as weeds.

I suppose it is hardly proper to refer to any plants not herbaceous as weeds. Yet when the planter finds a ligneous plant which is becoming a nuisance and which is fast making itself a pest, he wishes a word which will express his meaning to other people. Seven years ago the plantations of the vicinity contained many open forests, in which pines predominated, and in which the oaks though abundant were rarely thought of. These pines are *P. australis* Michx., *P. Taeda* L. and *P. mitis* Mx. Among these the first greatly predominates. With its long leaves, often 15 to 20 inches long, it adds fully as much to the picturesqueness of the south as does the pendent Spanish moss. It is also a valuable tree, not only for its turpentine and resin, for which it is the center of an important industry, but also for its lumber. To be sure, in the north its enormous weight would not permit it to stand competition with the lighter pines, but here in the south it is used for everything.

Now the oaks are coming in so thick as to obstruct and often to prevent the natural seeding and development of young pines. But this is not all. In a country where the climate is so favorable that cattle need feeding only two or two and a half months during the year, the raising of cattle and other grazing animals is an important industry. Now it happens that the invasion of oaks is so great that they shade so much of the ground as to check and limit the development of grass to a tremendous extent, and it is no longer possible to raise so many cattle to the acre without feeding. At present, the writer has before him a landscape of this description, into which these oaks have intruded within the knowledge of the present generation. Eighteen years ago it was all pine woods. A person could drive in any direction and the black-jack oak was only occasionally met. Even now it is rare to find any black-jack oak of any size. They commenced gradually to enter this territory, at first attracting but little attention. Seven years ago the danger of the black

jack oak invasion was already clearly foreseen, and now they are over many acres so thick as to interlock their branches, though the trees are only ten to fifteen feet high. Even on foot it is at times a nuisance to penetrate through the thicker growths, often several acres in extent.

The invasion seems to be from the north. At Marianna, and along the Appalachicola and Chipola in western Florida, they have not yet become a pest. West of the Flint the country was until lately quite free of them as a nuisance, but within the last several years reports have been coming in of the invasion of also that territory. Pines go deeper for their food. Oaks seem to require more potash and more phosphoric acid. Whatever the reason may be, nature, who has been raising pines for a long time, seems to have determined to quit the business, and has directed her attention to raising oaks. Perhaps the pines have exhausted the soil of certain elements, and have left others favorable to the growth of oaks in excess.

An additional observation must here be recorded. Fire is set in winter to the grass in the woods to act as a natural manure for the coming spring. The pines catch fire more easily, owing to their pitch, and the cambium layer is readily killed by heat. Oaks under similar circumstances suffer much less. A plantation house recently burnt down. Being a log and board house built of the rich pitch pine of the country, the heat was intense for an hour at a distance of a hundred feet. All the pines in the vicinity were killed. Five steps away from the sills of the house in the direction of the draft of the fire are black jack oaks, which have put out fresh branches all along the side of the tree away from the house, and those within a foot of the house are putting out branches from the roots. It was hoped that they were dead. Young fresh oaks are springing up everywhere near the burnt ground. Still this readier resistance to fire by oaks is only a very partial factor. On some plantations forest fires have not been allowed for some years on this account, but the oaks are still advancing. The worst oak in this respect is the black jack oak, *Quercus nigra* L., and it is to this oak that the term *weed* would apply. The Turkey oak, *Q. Catesbaei* Michx., is common but not feared.

Near the above mentioned house stood a pine about eight inches in diameter. A storm had inclined it to about fifteen

degrees from the perpendicular towards the north. Since then (in three years) the upper twenty-five feet of the tree had distinctly curved back towards a perpendicular, being inclined only about seven degrees. That it should have done so considering the thickness of the trunk even at this distance (thirty feet) from the ground seems strange.

A new compass-plant.

A walk through any bit of open woodland in July is certain to reveal the presence of quite a number of plants whose leaves have assumed a more or less vertical, instead of horizontal position, owing to a twist in the petiole, or, if the leaf be sessile, in the lower part of its blade, near the base. This is especially common among the *Compositæ*, where such names as *Seriocarpus tortifolius* Nees, and, possibly, *Solidago tortifolia* Ell. record the fact. A species of *Aster*, with ovate-oblong leaves, having a sessile, cordate base, shows a strong twist of the entire leaf towards the right or towards the left, but often in the same direction over the major portion of the same plant.

In *Sericocarpus tortifolius* the twist is confined to the narrowed base of the leaf; in some plants the twist is such that most of the lower leaves turn their upper surfaces towards the south, while the upper younger leaves do not show this tendency; in other plants even the lower leaves show no regularity as to which side is presented to the sun.

In various species of *Liatris* the twist is confined more or less to the lower half or third of the leaf and the twist is quite regularly in the same direction, so that looking at the plant from above the twist of the leaf blades gives it an effect a little like that of a screw. In general the twist is such that, holding the stem so as to place the leaf to be examined toward the right hand of the spectator, the upper surface of the leaf is directed towards him. *Liatris scariosa* Willd. shows this arrangement and *Liatris graminifolius* Willd. gives the screw-like effect very strongly. Other species of the genus show it. In a less distinct manner *Hypericum angulosum* Michx. shows the twisting of the leaf blades.

What is the meaning of this twisting of the leaf blade? Where the leaf blade is twisted throughout its entire extent the cause may be a little dubious, but where the twisting is confined to the basal portion of the leaf it seems quite evident that the resulting vertical portion of the leaf blade is

of service in evading more or less the full effect of the sun's rays during the hottest part of the day. This is true even of those cases of *Sericocarpus tortifolius*, in which most lower leaves face the south, since the vertical position of the leaf blades places them at an angle to the sun's rays which is more advantageous than a horizontal position would be.

The same result is secured in other plants by simply assuming an erect position. A form of *Linum Virginianum* L. is an interesting variation of this habit. Here the leaves are linear, 11^{mm} long, erect, appressed to the stem, and slightly twisted so as to fit still more closely against the stem, both toward the right and toward the left. The lower side of the leaves is thus exposed and the upper side more or less protected. In its earlier history the plant must have been simply a case of vertical leaves. *Aster adnatus* Nutt. must also at one time have had leaves entirely free from the stem, but erect, and more or less appressed to the same. In that position the lower half of the midrib became adnate to the stem and since then the upper half of the leaf has again resumed a tendency to spread.

It is *Aster concolor* L., however, which is the most interesting of the latter class of plants. Here the upper leaves are erect, appressed to the stem, and rather crowded. Towards the base they are larger, less numerous, and no longer so erect, but have rather an ascending position. They here also show a very marked tendency to place their vertical leaf blades in a north and south plane. This tendency disappears, or rather, is obscured among the more crowded and erect upper leaves. Where exposed to the sun freely the north and south position of the lower leaves is very evident and the plant thus becomes another case of a compass plant.

The case of the compass plant of the western states, *Silphium laciniatum* L., is too well known to require more than mention. A number of years ago, the writer, I think, had occasion to describe in this journal a similar phenomenon in thoroughly exposed plants of the prickly lettuce, *Lactuca Scariola* L. And now *Aster concolor* L., becomes a third. All of these belong to the *Compositæ*. The fact that these phenomena seem confined to those plants which delight in open sunny places, and which grow in the warmest part of the year, gives additional weight to the argument that they show evidence of a tendency to evade the hottest and most direct rays of the sun.

A curious rose.

A neighboring planter, Mr. Griffin, has a rose bush bearing constantly green roses. The calyx is fairly normal. The outer petals are small green simple toothed leaves, in other words, like any small leaflet from a rose leaf. The interior petals become less green, and more pale, and gradually less toothed, the upper teeth remaining the largest. The stamens are linear pale green flat petal-like bodies, abruptly expanded at the top, the outer ones notched at the apex. The achenia, on the contrary, are expanded at the base, and narrowed at the top, forming ovate lanceolate pale petal-like bodies. Of course there are no seeds, and the green roses appear on the same bush from year to year.

Fungi.

The first of July is the middle of the rainy season in the south, which lasts about two months. Florida and adjacent Georgia lie within the area of one of the heaviest rainfalls on this continent. During these months it rains frequently, often for several days. Yet there are almost no fungi of such kinds as would be apt to be found by a student not familiar with microscopic forms. A trip down the Chattahoochee and Appalachicola in May, and another down the Chipola, and through Dead Lakes, revealed almost no fleshy fungi, except a few specimens of a lateral stemmed *Agaricus* on a stump in the lakes. Fleshy fungi are, however, common in December and early January, and are moderately common again in February when the spring flowers begin to be frequent. No attempt was made to keep a record of the same. Prof. W. G. Farlow was so kind as to determine the following species of gasteromycetes for me, which are common late in December: *Rhizopogon rubescens* Tul., *Hydnangium Ravenelii* B. & C., *Lycoperdon acuminatum* Curtis (=*L. leprosum* B. & Rav.), and *Clathrus columnatus* Bosc.

Fossil palmettoes at Alum Bluff, Florida.

While on a geological trip with Prof. Raphael Pumpelly, the writer found that the palmetto leaves and trunks of that locality came from near the base of the middle Miocene Alum Bluff sands, just above the Chipola bed of which it represents the later fresh water facies. Above the sands lies the Chesapeake bed. This makes it probable that the wide spread Grand Gulf group of the lower Mississippi basin, in-

cluding localities providing similar palmetto leaves, also began its history at a date as early as the middle, pre-Chesapeake, Miocene. In this connection it may be of interest to notice that among the strongly washed marine fossils of Chipola age, at Gasteropod Gully, on Roseland Plantation four and one-half miles south of Bainbridge (owned by Prof. Pumpelly and Major T. B. Brooks), were found two land gasteropods, one a *Helix* somewhat resembling *H. adamnis* Dall, and the other four and one-half whorls from the upper part of a *Bulimulus*, similar to *B. Heilprinianus* Dall. In those days of the Chipola Miocene the Gulf Stream had a passage between what was then the island of Florida and the mainland of central Georgia and regions north. Gasteropod Gully must have been near the south shore of this mainland and received its land shells from that direction. The locality at Alum Bluff is also a marine deposit, as is shown by the oysters and other shells not at all so very rare in these Alum Bluff sands. Indeed the Chipola fossils run up into the base of these sands. Some of the oysters occur at higher levels than the plants. The water may, however, have been very shallow and brackish. The locality is a very important one in that it enables the correlation of horizons in the widely extended Grand Gulf deposits, with this more local sandy late Chipola bed. Hitherto there has been no *proof* of their earlier than post-Chesapeake Miocene age. The writer is of the opinion that the Grand Gulf series includes horizons which are equivalent in time to the earliest Miocene or Chattahoochee limestone deposits of Florida and southwestern Georgia, but this is hardly the place to develop this idea.

BRIEFER ARTICLES.

Three new species of Mexican plants.[1]—**Guarea Palmeri** Rose (*in littera*).—Foliis modice petiolatis 2–6-jugis, foliolis oppositis subsessilibus e basi cuneata oblongis vel obovato-lanceolatis apice obtusis supra glabris subtus ad axillas nervorum secundariorum pilosis, paniculis simplicibus racemiformibus, calyce obtuse 4-partito, ovario glabro 4-loculari loculis uniovulatis, capsula subglobosa glabra laevi, semine in arillo laete rubro immerso.—In Manzanillo (*Palmer* 1391).

Arbor mediocris 5^{m} alta glabra, Marte fructifera, corona lata symmetrica. Rami pallide fuscescentes lenticillis concoloribus. Folia $12–26^{cm}$ longa. Foliola ad 12^{cm} longa ad 4^{cm} lata in sicco firmula pallida subopaca epunctata supra nitentia, nervus secundariis utrinque circiter 8. Rhachis cum petiolo circiter 2^{cm} longo teres glabra. Paniculæ hornotinæ axillares. Capsula pallide fuscescens 2^{cm} longa 22^{mm} lata 4-locularis. Cotyledones transverse superpositi crassi, radicula inclusa, plumula minima.

Species *G. brachystachyæ* C. DC. et *G. filiformis* C. DC. affinis.

Trichilia Palmeri.—Foliis parvis modice petiolatis 3-foliolatis, foliolis petiolulatis lanceolatis basi aequali acutis apice breviter obtusa cuspidatis supra glabris subtus velutino-puberulis, paniculis glabris breviter ramulosis fructiferis quam folia multum brevioribus plerumque monocarpinis, capsulis apice ramulorum sessilibus globosis parvis, valvis ovato-acutis glabris extus nigrescentibus lenticellis pallidis numerosis conspersis, seminibus ellipticis.—In Mexico (*Palmer* 1,292).

Februario fructifera. Ramuli glabri pallide fuscescentes lenticellis albis conspersi. Folia ad 9^{cm} longa. Foliola in sicco firmo-membranacea inconspicue subtiliter pellucido-punctulata subpellucida, terminalia 7.5^{cm} longa 3^{cm} lata lateralia parum minora, nervis secundariis sub-

[1] While engaged in determining Dr. Palmer's collection from the state of Colima, Mexico, I came across three peculiar species that puzzled me very much. They all belong to the order Meliaceæ, none were in flower, but all had mature fruit. One I determined to be a new species of Guarea and the other two were tentatively referred to Trichilia. I finally submitted them to M. C. de Candolle, who has just reported upon them, requesting that his descriptions be published in the BOTANICAL GAZETTE. The following note accompanied his descriptions: "I did not answer sooner about these plants because two of them greatly puzzled me for some time, owing to the fact of their leaves and fruit showing all the outward characters of true *Trichilia* combined with the abnormal presence of perisperm in the seeds. But having received from Capt. John Donnell Smith a third plant with flowers as well as fruits, which unmistakably belongs to *Trichilia*, although its seeds contain perisperm, I now hesitate no longer to refer yours to the same genus."—J. N. ROSE.

adscendentibus suboppositis utrinque 8–10. Petioluli ad 6^{mm} longi subtiliter puberuli. Petioli ad 2^{cm} longi. Paniculæ hornotinæ axillares glabræ. Capsula paulo latior quam longa, circiter 7^{mm} lata. Semina circiter 4^{mm} longa elliptica in sicco flavicantia. Embryo perispermio albo tenui inclusus, cotyledonibus carnosis basi cordulatis, radicula exserta subrotunda, plumula minima.

Species sicut subsequens ac tertia e Guatemala alio loco describenda semine perispermium includente radiculaque e cotyledonibus exserta a caeteris *Trichiliis* quorum fructus notus est discrepans.

Trichilia Colimana.—Foliis modice petiolatis 5–6-jugis, foliolis subaequalibus petiolulatis oppositis subalternisve lanceolatis basi leviter inaequali acutis apice acute acuminatis supra subtusque densius pilosulis, paniculis fructiferis simplicibus quam folia pluries brevioribus, capsulis pedicellatis 3- vel abortu 2-valvatis, valvis late ovatis transverse rugulosis hirsutis, loculis monospermis, seminibus subglobosis arillo aurantiaco circumdatis.—In Colima (*Palmer* 1,117).

Ramuli adulti glabri, in sicco rufescentes lenticellis pallidioribus inconspicuis. Folia ad 30^{cm} longa impari-pinnata. Foliola superiora caeteris parum majora ad 7.5^{mm} longa ad 22^{mm} lata in sicco firmule membranacea inconspicue subtiliter pellucido-punctulata, nervis secundariis subadscendentibus utrinque 10–12. Rhachis cum petiolo 7^{cm} longa teres pilosula. Paniculæ fructiferæ circiter 8^{cm} longæ. Capsularum valvae circiter 1^{cm} longae. Embryo intra sacculum persistentem extus perispermio pulverulente albo circumdatum inclusus, cotyledonibus carnosis ellipticis, radicula exserta brevi obtusa, plumula minima. —Casimir de Candolle, *Geneva, Switzerland.*

Frost freaks of herbaceous plants.—The very interesting article by L. F. Ward on "Frost Freaks of the Dittany"[1] called to my mind some very interesting observations which I made on this plant during the winter of 1885–6, while connected with the University of North Carolina. This plant is very abundant in the open woods at Chapel Hill where the University is located. During a short excursion one frosty morning the curious frost foils on the stems of *Cunila* attracted my attention. On these particular plants the frost laminations did not usually conform to the regular arrangement described by Mr. Ward, though sometimes the regular arrangement in whorls of two or four did occur. The sheets did however stand out vertically from longitudinal slits in the stem and were curved into multitudinous forms forming imitations of numerous objects. One case I particularly remember where two sheets issuing from parallel rifts quite near together, diverged as they extended outward from the stem, and then

[1] Botanical Gazette, **18**: 183. 1893.

gradually approached forming a perfect imitation of the shell of some lamellibranch. I found upon observation that the longitudinal bars on the sheets were due to slight inequalities in the thickness, caused by corresponding inequalities in the size of the rift in the stem. During the process of crystalization of the water at the surface of the cambium layer its expansion caused it to be expressed outward or vertically to the plant since this was the direction of least resistance to the forming ice foil. The forming crystal passing through the rift would be moulded into a fashion, so far as the thickness is concerned, corresponding to the inequalities of the rift. During the first stages of the crystalization frequently portions of the dead epidermis or periderm would be included, and as the foil extended outward considerable portions of the dead outer part of the stem would be carried out upon the terminal portion.

Although familiar with the frost freaks of *Helianthemum Canadense* from the statements in manuals, I had never seen them, and this phenomenon on the stems of *Cunila Mariana* seemed to me to be of some interest which would possibly justify some extended notice of it together with colored illustrations. Accordingly I engaged an artist friend to color in oil one of the most beautiful of the specimens. Since the frost work could not be taken in doors without fatal results to its form and beauty, and it would be rather chilly working at an easel in the frosty air of a cold morning, the object was placed just outside the window while the artist sat within. A very good picture was the result but further consideration of the subject led me to believe that the phenomenon was of such common occurrence throughout nature it was not worthy of the very dignified treatment which I had in mind at the start. So the matter dropped so far as I was concerned and this interesting phenomenon waited seven long years to be recorded.

Several mornings during that and following winters the frost marvels were observed, and each time also there occurred the well known phenomenon of the formation of ice columns in moist soil, where the crystallization of the surface moisture causes the forming crystal to expand vertically to the earth since that is the direction of the least resistance. Capillarity of the soil provides the constant supply from below where the soil is not frozen, and columns are pushed up several inches in height, carrying upon their summits portions of the surface soil and refuse matter in the way of leaves, etc. Warm or mild days and frosty nights, when the ground is not already frozen, favor both the formation of the ice columns in moist places on the ground, and the frost wings on the stems of the dittany. The peren-

nial root system probably does not supply by capillarity the constant stream of water as does the capillarity of the soil. But I do not think it unreasonable to suppose that there is a degree of root activity which furnishes the necessary water. The cold being superficial the water in the surface of the cambium crystallizes, the dead periderm cracks, and through the rift the nascent laminate crystal pushes its way.

A specific variation in the root activity of different plants as related to different temperatures explains, I think, why *Cunila Mariana* of all the plants Mr. Ward mentions forms the crystals. I discovered also one other plant which produced these frost freaks, but as the subject was losing what had seemed to me at first its very serious aspect, I did not take the trouble to accurately determine either the species or genus of this additional frost weed. From the observations which I made at the time I can safely say that it was either some species of *Eupatorium* or *Vernonia*, more likely the latter. I regret now that I did not accurately determine the species.—GEO. F. ATKINSON, *Botanical Department, Cornell University.*

A hybrid Baptisia.—Several specimens of a *Baptisia* have been collected in the vicinity of Manhattan which can not be referred to any of the species of the genus. The two species occurring here are *B. australis*, characterized by its glabrous foliage and erect raceme of blue flowers, and *B. leucophæa*, with hairy foliage and a reclining raceme of cream-colored flowers. The specimens referred to are intermediate in all these characters, even to the party-colored flowers, and are apparently hybrids between the two species. Fruiting specimens have not been observed.—A. S. HITCHCOCK, *Agricultural College, Manhattan, Kansas.*

CURRENT LITERATURE.

Microscopical methods.

American botanists are much indebted to Dr. James E. Humphrey for translating and to Messrs. Henry Holt & Co. for publishing a very valuable work on botanical microtechnique. The work was written by Dr. A. Zimmermann,[1] privat-docent in the University of Tübingen, and published in Germany last year.

It is rare that such a wealth of detailed information is condensed into so small space. The general methods of observing, staining and mounting specimens are first taken up, followed by microchemical methods, methods for investigating the cell wall and the various cell contents, some account of the preparation and examination of bacteria, and a list of literature and an index. The variety of substances which may now be detected microchemically is astonishing. Over one hundred compounds or groups of compounds are treated in the third of the volume given to microchemical methods. An equally great number of substances are dealt with in the next third of the volume, relating to the cell wall and cell contents.

In using the work some disappointment will be felt now and then on account of the brevity with which many of the topics are treated, but this fault, arising from the multiplicity of topics, is partly atoned for by the careful citation of literature, the page as well as the volume being named.

Nearly two hundred authors are mentioned in the enumeration of literature, and two or three times as many distinct works. The text has not, however, been merely compiled from these abundant data, but the author has tested a large part of the methods, and given his views of their value, often suggesting excellent modifications.

The work of the translator has been well done. He has taken occasion to add a few items to the text, the most important being in regard to celloidin imbedding. He has also added to the appendix a series of very useful reference tables, notably a table of specific gravities and percentage composition of a few common solutions and De Vries' table of "isotonic coefficients" comparing the water-absorbing power of six great groups of compounds. The author has also

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[1] ZIMMERMANN, A.—Botanical microtechnique: a handbook of methods for the preparation, staining, and microscopical investigation of vegetable structures. Trans. from the German by JAMES ELLIS HUMPHREY. 8 vo. pp. 296. figs. 63. New York: Henry Holt & Co. 1893. $2.50.

assisted the translator in supplying paragraphs upon recent investigations, thus bringing the work fully up to the time of publication of the American edition.

The typography and binding are satisfactory. Altogether the book is admirable, and no microscopical laboratory can afford to be without it.

Minor Notices.

THE MYRTLES of Brazil have just been enumerated by Hjalmar Kiærskou[1], being a part of the work on the flora of Central Brazil edited by Eug. Warming. This characteristic Brazilian family is represented as containing 418 species, 120 of which are described as new. Of the 13 genera, *Myrcia* and *Eugenia* contain over 300 of the species. *Myrcia* is represented by 154 species, 37 of which are new, and *Eugenia* by 151 species, 52 of which are new. Only the new species are characterized. Of the 24 plates, 12 are from drawings, chiefly showing leaf form and venation, and 12 are very good reproductions of photographs of herbarium sheets.

DR. JOHN W. HARSHBERGER has published an exhaustive account of maize.[2] He has brought together matters of great interest, and this contribution will make a valuable reference paper. The scope of treatment can best be indicated by some of the titles. The chapters bear the titles: Botanical, Origin, Geographical Distribution, Chemical, Agriculture–Physiological, Utility, Economic considerations, Future. Under "Botanical", the gross anatomy, histology, and bibliography, are treated. Under "Origin", which is a very interesting chapter, meteorological, botanical, archæological, ethnological, philological, and historical proofs are considered, all of which are taken to prove a central Mexican origin. "Maize originated, in all probability, in a circumscribed locality, above 4,500 feet elevation, north of the Isthmus of Tehuantepec and south of the 22nd degree of north latitude, near the ancient seat of the Maya tribes. There is hardly a doubt but that the Mayas first cultivated maize and distributed it in every direction."

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[1] KIÆRSKOU, HJALMAR.—Enumeratio Myrtacearum Brasiliensium, etc. 8vo. pp. 200, 24 plates. Hauniæ, ex officina Hoffensbergiana, 1893.

[2] HARSHBERGER, JOHN W.—Maize: a botanical and economic study. Contrib. Bot. Lab. Univ. Penn. **1**: *2*. 75–202. *pl. 4*. 1893.

NOTES AND NEWS.

DR. JOS. BOEHM, professor of physiological botany in the University of Vienna and also in the College of Agriculture, and an investigator of wide reputation, died December 2, 1893, at Vienna.

DE LAMARLIERE finds[1] that, for an equal surface, the leaves developed in the sun show a greater intensity of respiration, assimilation and transpiration than those grown in shade, the well known structural differences thus having a corresponding physiological significance.

IN PRESERVING anatomical as well as herbarium material, Heinricher avoids blackening of colorless saprophytes and parasites like Monotropa and Lathraea by plunging the living plant into boiling water for about a quarter of an hour and then transferring them to alcohol or placing in a press, as desired.[2]

MUELLER-THURGAU has shown that various phenomena in cultivated grapes, currants, apples, oranges, apricots and peaches, are directly related to the number of seeds formed. The more seed formed the greater will be the weight of flesh, the slower the ripening, the greater the amount of acid and the less the sugar.

MR. O. F. COOK sailed Oct. 25th for western Africa, to make further observations and collections of the plants of that region, especially of the cryptogamic forms. He will be gone a year or more. His former voyage resulted in securing a large amount of botanical material, and the present visit is expected to yield even greater results.

MACMILLAN & Co. of New York announce for early publication a work by Prof. G. F. Atkinson, entitled, "The study of the biology of ferns by the collodion method; for advanced and collegiate students." It is to be profusely illustrated, and is designed for laboratory instruction and for reference on the development and structure of ferns.

FOR MOUNTING preparations cleared with chloral hydrate which it is desired to retain in their transparent condition, Geoffroy suggests[3] a solution of 3–4^{gm} pure gelatin in 100^{cc} of 10 per cent. chloral hydrate. This can be used like glycerin, with the added convenience that it hardens at the edge of the cover, so that the cover can be cemented without tedious cleaning.

QUANTITATIVE DETERMINATION of sugars by fermentation is described by A. Lasché in the *Amer. Brewer's Review* **7**: 286–288. 1893. The method is given by which the percentage of dextrose, saccharose, maltose and isomaltose in glucose can be found by use of Saccharomyces apiculatus, S. Joergensenii, and S. cerevisiæ. Two types of the latter are required, the Frohberg type and the Saar type.

[1] Revue gén. de Bot. **4**: 481, 529. 1892.

[2] Zeits. f. Wiss. Mikros. **9**: 321–3. 1893.

[3] Jour. de Botanique **7**: 55. 1893.

DR. F. FRANCESCHI, of Los Angeles, Cal., has made a small collection of the Guadalupe Island plants. The plants of this island have been seldom collected. Although quite well known through collections of Dr. Palmer and Professor Greene, so many of the species are endemic, that almost any collection from the island is valuable. Dr. Franceschi has several sets to dispose of and solicits correspondence.

THE QUESTION of the existence of a special membrane around the vacuole has been incidentally studied by Bokorny, who finds,[1] on treating cells with a 1 per mille solution of coffein, similar phenomena to those described by DeVries upon plasmolysis with a 10 per cent. sâlt solution. By the treatment with so weak a solution no plasmolysis occurs but the general protoplasm is slowly killed. The vacuole wall however remains living for a long time as shown by its reactions.

AGRICULTURAL SCIENCE, a journal of scientific merit, containing frequent articles upon botanical and other biological subjects, finds it necessary to increase its subscription price, after the close of the present year, from two dollars, the former price, to three dollars per year. This is for the porpose of enabling the publisher to keep up the high standard of quantity and quality of matter presented, which has already been attempted, but for which the financial support is not at present adequate.

A PROSPECTUS of a distribution of *Uredineæ Americanæ Exsiccatæ* by Prof. M. A. Carleton, has been issued. The fascicles are to contain fifty specimens which are to be sent out in white paper pockets, loose, with printed labels. The nomenclature will follow the best authorities, and notes on literature will find a place on the labels. Any one contributing sufficient material for four numbers of the distribution will receive a set free. The first fascicle is to be sent out about the middle of January.

THE PROCEEDINGS of the sixth annual convention of the *Assoc. of Agric. Colleges and Stations* (1892), recently distributed as Bulletin 19 of the U. S. Office of Exper. Stations, contains five botanical papers in full, viz.: On the treatment of apple scab, by E. S. Goff; A comparative test of fungicides in checking potato blight and rot, by L. R. Jones; A study of fruit decays, by B. D. Halsted; Notes on the breeding of fruits, by N. E. Hansen; and Crossing of cucurbits, by L. H. Pammel. The report of the section on botany gives a brief resumé of ten papers that were presented.

MR. G. J. PEIRCE publishes in the *Annals of Botany* for September the results of investigations on the haustoria of the Cuscutas and some other phanerogamic parasites. The author finds the haustoria to be true lateral roots modified for their special work. In all the five genera studied, except the chlorophyll-bearing *Viscum album*, the mature haustorium was provided with an axial bicollateral bundle with two strands of ducts and two of sieve tubes. The haustorium of the parasite always penetrates to the fibro-vascular ring of the host and its xylem and sieve tubes are in direct communication with the corresponding parts of the host. The finding of sieve tubes in the haus-

[1] Biolog. Cent. **13**: 271. 1893.

toria of the Cuscutas when L. Koch and others had failed to discover them is especially interesting and throws much light on the food relations of the parasite and its host.—R. A. HARPER.

A great portion of native botanic drugs are collected in the mountain portions of North Carolina, South Carolina, eastern Tennessee and Kentucky and northern Georgia. The inhabitants of these regions, many of them, eke out a precarious living collecting drugs; men, women and children take part in the work. Gathered as they are by people who are often densely ignorant it is necessary before the drugs are put upon the market for them to pass through the hands of persons who make it a business to inspect, sort and identify the goods. In the pharmaceutical laboratory of Eli Lilly & Co., of Indianapolis, Ind., a botanical department [in charge of Mr. John S. Wright] is devoted to the identification and inspection of vegetable drugs.—*Lilly's Bulletin, No.* 23.

THE SERIAL, *Studies from the biological laboratory of Johns Hopkins University*, completed the fifth volume with the October issue. A general title page and index to the five volumes accompanies the last number. The botanical articles in these five volumes are as follows: Botanical relations of Trichophyton tonsurans, by I. E. Atkinson (I, No. 1.; Land plants found at Fort Wool, by N. B. Webster, (I, No. 3); Researches on the growth of starch grains, by A. F. W. Schimper (II. 353); Observations on several zooglœæ and related forms, by William Trelease (III. 193); Formation of the so-called cypress knees on the roots of the Taxodium distichum, by J. P. Lotsy (V. 269); and On the origin and development of the stichidia and tetrasporangia in Dasya elegans, by B. N. Barton (V. 279).

IN AN EXAMINATION of fifty species of fungi belonging to widely separated groups, by W. Wahrlich of St. Petersburg, in an article on the anatomy of the cell in fungi and unicellular algæ (in the Russian language), all were found to show a continuity of the protoplasm, except Oidium lactis, not only between vegetative cells, but also between the hyphæ and spores, and between the parts of many-celled spores. The connecting bands were clearly strands of plasma. The author arrives at the conclusion that the continuity of protoplasm is present in the fungi wherever transportation of material is necessary, and that plasma granules may pass from one cell to another in this way. In an experiment with Eurotium herbariorum this happened under the eye of the observer. (Cf. BOT. GAZ. 18: 437).—D. T. M.

THE ANNUAL MEETING of the Indiana Academy of Sciences occurred in Indianapolis, Dec. 27th and 28th. There was a good attendance, and the scientific interests of the state were promoted in many ways. One half day was given to the discussion of the work accomplished by the State Biological Survey, a voluntary organization under the auspices of the Academy, and of plans for its future. The following are the titles of the botanical papers read: Some notes on a variety of Solanum Dulcamara, by R. W. McBride; Review of botanical work in Indiana with bibliography, and Our present knowledge of the distribution of pteridophytes in Indiana, by L. M. Underwood; Histology of the Pontederiaceae, by E. W. Olive; Growth in length and

thickness of the petiole of Richardia, by Katherine E. Golden; The effects of light on the germinating spores of marine algae, by M. A. Brannon; Notes on Saprolegnia, by Geo. L. Roberts; Contribution to the life history of Notothylas, by D. M. Mottier; Notes on evolution in the cacti, by J. M. Coulter; The ash of trees, Notes on the biological survey, and The stomates of Cycas, by M. B. Thomas; Poisonous influence of Cypripedium spectabile, Symbiosis in Isopyrum biternatum, and Work of the botanical division of the Natural History Survey of Minnesota, by D. T. MacDougal; Notes on sectioning woody tissues, Concerning the effect of glycerin on plants, and Notes on an imbedding material, by John S. Wright; and The adventitious plants of Fayette county, by Robert Hessler. Beside the above the presidential address by J. C. Arthur was a botanical theme. The special senses of plants.

DR. H. SCHENCK recommends[1] a method of preparing unusually large and thick sections for permanent preservation so as to be useful for lecture demonstrations and for examination with the magnifier. The sections are first thoroughly permeated by glycerin by prolonged soaking; the superfluous glycerin is drained off and the section dried with filter paper; it is then placed in an abundance of a thin solution of Canada balsam in xylol and covered with a large cover glass. The glycerin does not mix with the balsam nor is it withdrawn from the object which remains perfectly clear. The method is applicable to sections of stems of large size, such as tree ferns, palms, etc., whether woody or herbaceous. Of course suitable sizes of slides and covers have to be obtained.

IMMEDIATELY FOLLOWING the World's Congress on Horticulture at Chicago in August last, a series of meetings was held to consider the advisability of organizing a horticultural society which shall include every country of the globe. After much discussion, in which many eminent men from various parts of the world engaged, the World's Horticultural Society was organized and the election of the three general officers was held, on the 25th of August. This new society is designed, in the language of the constitution, "to promote correspondence and to facilitate exchange of plants and information between the countries of the world." This society can coördinate and extend the work of all existing societies, compile statistics, promote legislation and education, prepare correspondence directories, diffuse all the latest information from the various parts of the globe, consider means of transportation, and facilitate the exchange of varieties and every commodity in which pomologists, viticulturists, florists, vegetable gardeners, and other horticulturists are interested. The Society will probably meet occasionally at the various International Exhibitions, upon which occasions, also, it can greatly aid in procuring exhibits from all parts of the world.

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[1] Bot. Cent. **54**: 1. April 1893.